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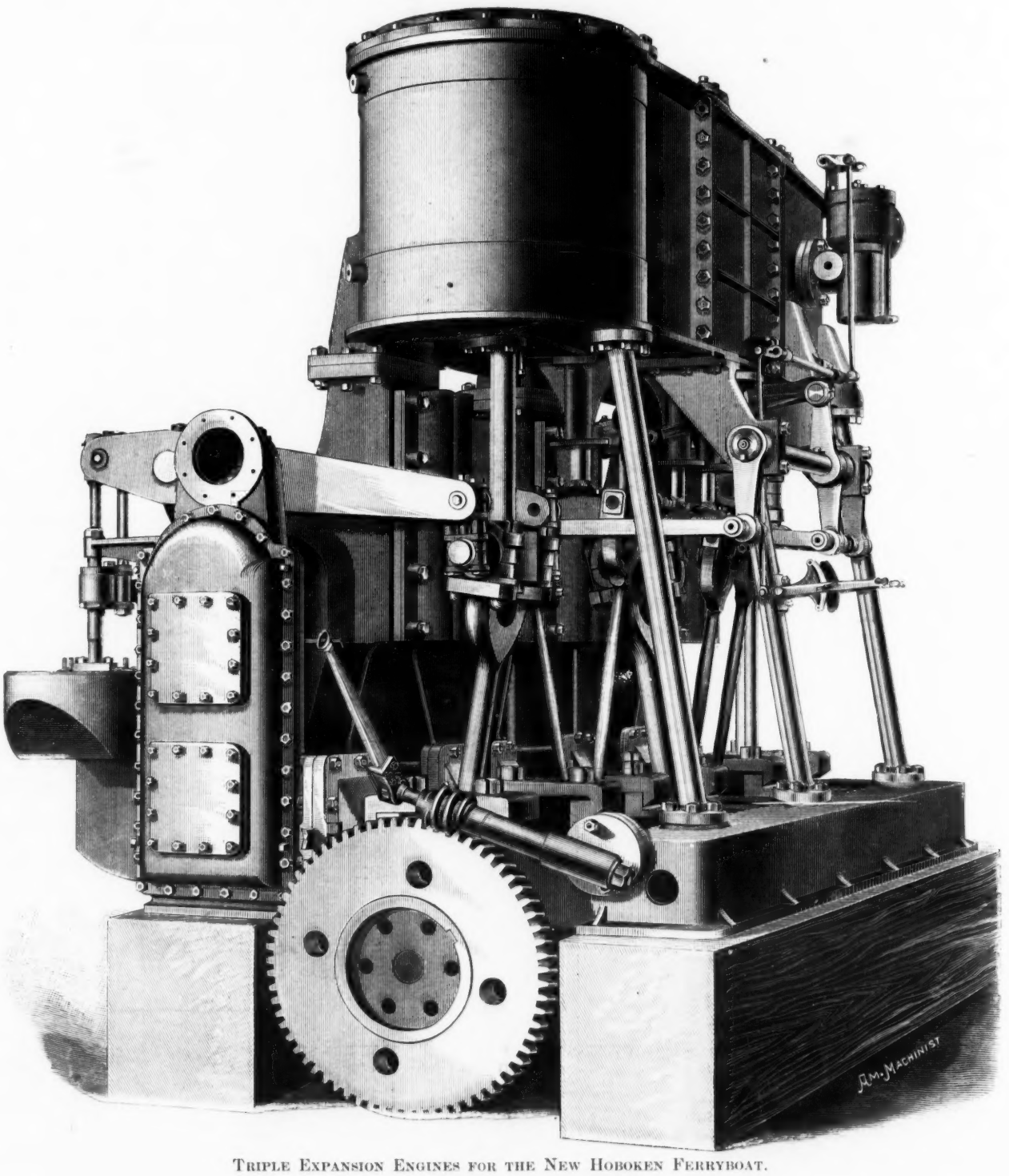
Triple Expansion Engine for the New Hoboken Ferryboat.

A new ferryboat, to be named "Bergen," is now in the course of construction for the Hoboken Land and Improvement Co. The boat is 200 feet long and 37 feet beam; its depth of hold is 17 feet, and draft 8 feet 9 inches. The boat was built by T. S. Marvel & Co., Newburgh, N. Y., and launched October 25, 1888. The engine, of which we give a perspective view on this page, and sections of its cylinders and valves on page 2, was built at the De Lamater Iron Works, New York City, and is now being placed in the boat.



TRIPLE EXPANSION ENGINES FOR THE NEW HOBOKEN FERRYBOAT.

The propeller shaft is made of wrought-iron, 8¾ inches diameter; it will extend through the whole length of the boat, with a propeller wheel at each end. These propellers are made of cast-steel; diameter, 8 feet; pitch, 9 feet 3 inches. The high-pressure cylinder, Fig. 1 (page 2), is 18½ inches in diameter; the intermediate-pressure cylinder (Fig. 2) 27 inches, and the low-pressure cylinder (Fig. 3) 42 inches in diameter; the stroke is 24 inches. The distance between the centers of the H. P. and I. P. cylinders is 67 inches, and that between the I. P. and L. P. cylinders 56½ inches. Suitable hand-holes are provided, so as to avoid taking the cylinders apart after they have been bolted together.

The cylinders are supported by cast-iron columns, cast to the condenser, and wrought-iron supports 4¼ inches diameter, reaching from the underside of the cylinders to the bed-plate. The cast-iron bed-plate is of a box form, 14 feet 5½x5 feet 2 inches over all.

The main bearings, six in number, are placed comparatively low in the bed-plate. The bearings are 8¾ inches diameter and 10¾ inches long; they are made of cast-steel, with bronze rings fitted in the ends, and six bronze staves running lengthwise in each bearing, so as to leave oil recesses.

The crank-shaft is of wrought-iron. At one of its ends the turning gear is attached, which consists of a worm wheel keyed to the shaft coupling. This wheel engages with a worm which is worked with a ratchet lever, and thereby the shaft is made to revolve. In order to take the worm out of gear it is swung around the pivot, which is bolted to the end of the bed-plate, as shown in the illustration.

The connecting rods are made of wrought-iron, 4¼ and 3¾ inches diameter; length from center to center, 5 feet 8¼ inches. These rods have forked ends for the crossheads. The boxes in the forked ends are made of cast-steel, fitted like the main bearings, and bolted to the rod with two bolts 2¼ inch diameter. In the single ends of the rods the boxes for the crank-pins, 8¾ inches diameter, 9 inches long, are also made of cast-steel, fitted like the main bearings, and bolted to the rod by two bolts, 3 inches diameter.

The crossheads are made of wrought-iron, and provided with cast-iron babbited gibs, working along cast-iron guides, which are bolted to the columns cast to the condenser. The wrought-iron piston rods are 4¼ inches diameter. The pistons are made of cast-steel; the depth of surface working along the cylinder surface is 5 inches, and contains a single cast-iron split ring, with tongue and groove joint.

The throttle valve is 7⅞ inches in diameter, valve seat $7\frac{5}{16}$ inches. The throttle valve is balanced by a $7\frac{1}{16}$-inch piston. This valve has a 1¼-inch connection with the low and intermediate receivers, so that into these can be admitted, by the use of reducing valves, steam of 10 pounds' pressure. The connection can be shut off as soon as the engine is started. The throttle valve is also provided with a drip, by which, after the valve has been closed, the pressure can be taken off from behind the piston, and the valve kept on its seat by a pressure of over three tons. The valve is opened by a system of levers and rock shaft fastened to the middle support of cylinders.

The valves for the low and intermediate-pressure cylinders, Figs. 6 and 5 respectively, are common, double-ported slide valves, having a suitable amount of lap. The valve for the high-pressure cylinder, Fig. 4, is a piston valve 9 inches in diameter, and working in a cast-iron liner, such as is shown in Fig. 7. This valve also has lap. All the valves have a common travel of 4½ inches. The valve stems are 2¾ inches diameter in the stuffing boxes and 2 inches diameter in the valves.

The engines are reversed by an ordinary link motion. The links are made of two wrought-iron pieces 4¼ inches wide, 1⅜ inch thick, and bolted together so as to leave a space 4¾ inches between them. The radius of link is 5 feet 9½ inches, and the eccentric rod-pins are placed 18 inches apart from center to center. The link blocks have brass gibs, so as to provide means for taking up lost motion.

The eccentric rods are 2½ inches in diameter; the link ends are forked and fitted with brass bearings, straps, keys, etc.

The eccentrics are 17 inches diameter, 3½ inches face, and 2¼ inch throw; straps of cast-iron and babbited.

The reversing engine has a cylinder 10

inches diameter and 18 inches stroke. It is bolted to the condenser in a position such as to bring its piston rod and guides between the high and intermediate-pressure valve stems. The reversing valve is worked by a hand lever attached to a quadrant, which is fastened next to the throttle lever and quadrant.

The cast-iron exhaust pipe, 15 inches x 10 inches, runs direct to the condenser.

The condenser is cast in two pieces and bolted together. It is 13 feet 10½ inches long, 16½ inches wide, and 58 inches high inside. It contains six hundred and thirty-six brass tubes tinned, giving a cooling surface of 1,717 square feet. The tubes are packed with corset cord and brass bushes screwed in tight. The inlet and outlet pipes are each 9 inches diameter. The opening to air pump is 24 inches by 5 inches.

The diameter of air pump is 24 inches, stroke 6 inches. The cast-iron pump barrel is lined with sheet brass keyed in. The foot valve is made of brass and provided with six 6½-inch hard rubber valves. The air pump bucket and delivery valves are also made of brass, and each provided with six 6½-inch valves. The rod is of wrought-iron forced into a brass tube 3¼ inches outside diameter. The air pump is worked by two beams keyed to one shaft, and receive their motion from the low-pressure cylinder crosshead to which they are attached.

Two thrust bearings, one on each side of the engine, are used. They are made up of eleven collars, 12½ inches diameter, forged to 8½-inch shaft, and work in babbited bearings.

The stern pipes are made of cast-iron, 12 feet 5¼ inches long and 12¼ inches diameter; their outer ends are lined with lignum vitæ, forming a bearing 9⅜ inches diameter, 38¼ inches long. The inner ends are lined with brass, forming a bearing 9⅜ inches diameter and 18 inches long; this end is also provided with a stuffing box.

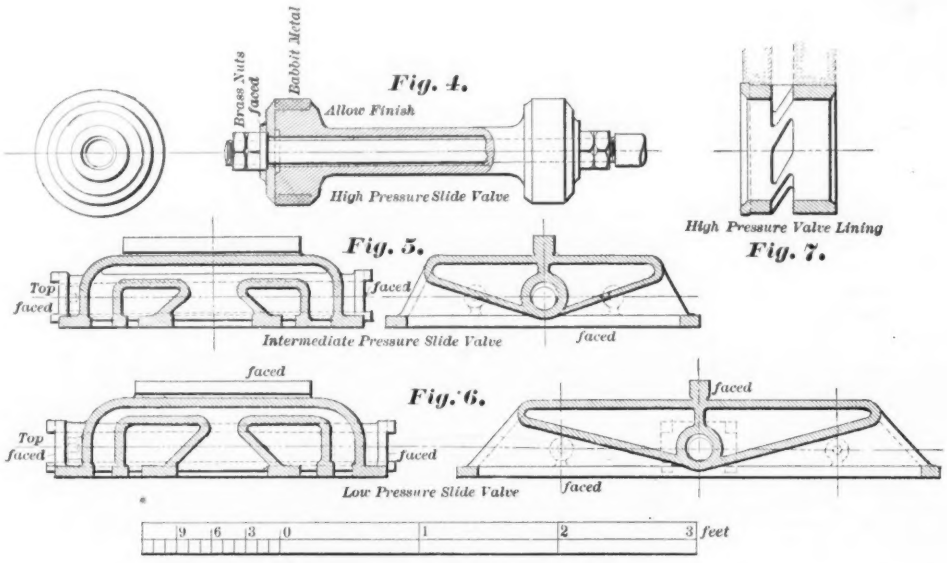
Two cylindrical boilers are used, built for a working pressure of 160 pounds. They are 8 feet diameter, 23 feet long. The shells are made of steel, 11/16 inch thick, 60,000 pounds T. S. Longitudinal seams triple riveted, seams around the circumference double riveted; all holes drilled. Tube heads of steel, ⅝ inch thick. Two flues of ½-inch steel strengthened with four 2¾-inch half round iron bands in each boiler; diameter of flues, 39 inches, 9 feet 3¾ inches long and 44 inches between centers. Each boiler contains 204 tubes 2½ inches diameter, 11 feet long.

The heating surface in two flues = 119.5 square feet.

Heating surface in comb. ch'r, sq. ft. = 58.5
" " 204 tubes " = 1457.5
1635.5

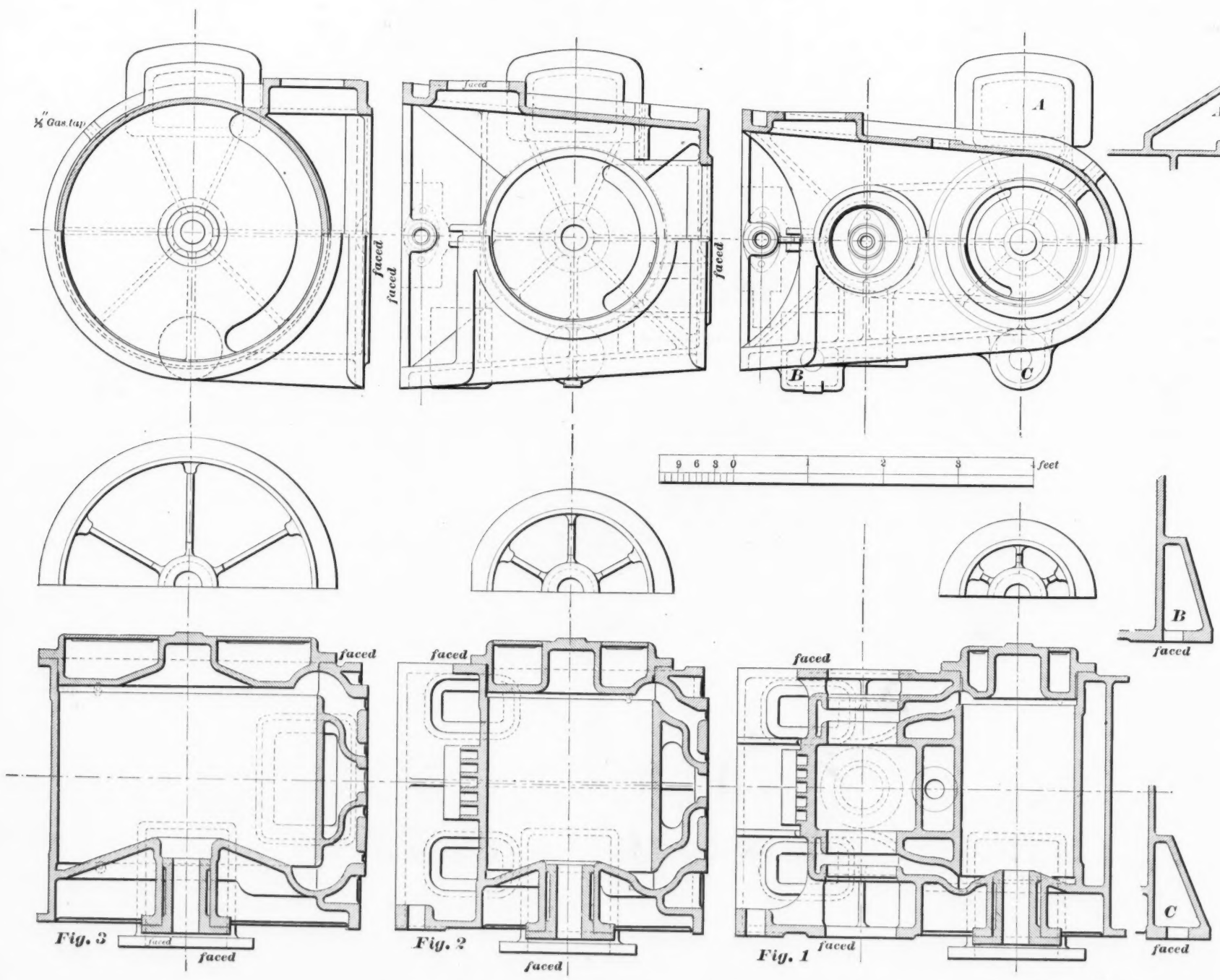
Heating surface in both boilers:
1635.5 × 2 = 3271.0 square feet.
Grate surface in each boiler, 42.75 sq. ft.
" " " two " 85.50 "
Ratio of heating surface to grate
= 1635.5 ÷ 42.75 = 38.26 : 1.
Ratio of area through tubes to grate
= 42.75 ÷ 5.8 = 7.37 : 1.
Net steam space, 540 cubic feet.
High-pressure cylinder, 18½ inch × 24 inches
= 3.733 cubic feet.
Ratio of steam space to high-pressure cylinder = 540 ÷ 3.733 = 144.7 : 1.
Ratio of heating surface to high-pressure cylinder = 3271 ÷ 3.733 = 876 : 1.

In the perspective view the engine is shown on wooden blocks as erected in the shop. In the boat the engine is bolted to wrought-iron keelsons.



Dr. Coleman Sellers, Professor of Practical Engineering in the Stevens Institute of Technology, Hoboken, N. J., will deliver six lectures at the institute during November. The first lecture was delivered Nov. 7th. The lectures will be delivered at 3 o'clock, P. M.

An electrically-driven pleasure boat, 65½ feet long, 10 feet beam, to carry eighty passengers, was launched in the Thames on October 15th. The electrical machinery and storage cells are placed below the deck fore and aft, leaving a clear run the whole length of the boat for passengers. In the middle is a handsomely-fitted cabin with lavatories, dining-table, etc. The electrical energy is stored in 200 E. P. S. accumulators, and is converted into motive power by two motors of 7½ horse-power each, driving twin three-bladed propellers, by Thornycroft & Co. The launch is owned by Messrs. M. Immisch & Co., by whom it was built, under the direction of Mr. Sargeant, and is designed to attain a speed of six miles an hour.—*Ironmongery.*



TRIPLE EXPANSION ENGINE OF THE NEW HOBOKEN FERRYBOAT.—SEE PAGE 1.

A Chicago man claims to be able to roll a complete chain from a bar of iron or steel, thus avoiding all welds.

Force in the Steam Engine, and its Relation to Smooth Running.

FIFTH PAPER.

BY PROF. JOSEPH TORREY.

In previous articles it has been shown how force was required to set the reciprocating parts in motion at the beginning of the stroke, and to stop them at the end. It has also been pointed out that if the connecting rod were infinite in length the piston speed would be the same at both ends, and, consequently, the inertia would be the same, resulting in a uniform decrease of inertia during the first half, and increase during the latter half. We are now first to see how the connecting rod length affects the shape of the inertia line, and secondly, to find a method of laying out the *inertia line* for any engine.

We can answer the first of these inquiries by means of what we have already learned. We know that the piston speed will be faster at the back or head end. The result of this will be that greater speed will have to be given to the reciprocating parts at the head end, and this will require greater force; that is, inertia will be greater at the head end than at the crank end. We also know that the greatest velocity of the reciprocating parts is reached before mid-stroke of the piston. That is, the point where the velocity stops increasing and begins to decrease, and where, consequently, for an instant there is no inertia, will be somewhat before mid-stroke. The effect of this on our inertia diagram will be that the inertia line will cross the neutral line before reaching its middle point *E*. Another result will be that, since the speed of the reciprocating parts builds up so much more rapidly at the back end, the inertia line will *drop* just as rapidly; while at the crank end, where more time is given to stop the reciprocating parts, the inertia (which, at this end, means resistance to being stopped), will also build up gradually.

Putting these things together, it will be seen that, in order for the inertia line to pass through the points *C' E'* and *D'* (Fig. 1), it will have to be a *curved line*. The exact shape of the curve will depend on the length of the connecting rod, but there will always be curve, in case of any steam engine whose connecting rod is measurable in length. For the backward stroke the diagram will be just the same, only what was resistance to motion in the first diagram, and, consequently, measured above the line *A B*, will be resistance to retardation, and, consequently, measured below this line.

Now, just here is a good place to notice one fact of a good deal of practical and every-day interest, namely, that the areas of the two halves of an inertia diagram for one stroke are equal. Thus, in Fig. 1 the area of *C' A E* is equal to area of *D' B E'*. These areas, moreover, represent force, and one means resistance to motion, and the other resistance to retardation. Then it follows that the total amount of force required to start the reciprocating parts, and bring them to full speed, is exactly equal to the force with which they resist being brought to rest in the latter part of the stroke. In other words, the reciprocating parts pay back in the latter part of the stroke the force that was used up in starting and accelerating them. This disposes, I hope, of the notion, which is a very common one, that heavy reciprocating parts are a source of loss of power, and later on it will be shown how many times over they "pay their passage" in benefiting the general running qualities of the engine

Our next problem is *the* problem toward which we have been working, namely, to lay out the inertia curve for any engine. This problem we shall have to subdivide and consider in several divisions. Inertia in a body at rest depends on three things: first, its weight, and second, the velocity to be imparted to it, and third, the time given in which to impart this velocity. It will readily be seen that the amount of inertia force will vary directly as the weight (*i. e.*, as the weight increases the inertia will increase, or the reverse), directly as the velocity and inversely as the time (*i. e.*, as the time allowed is longer, the amount of force required will be less, or the reverse). Hence, knowing all these things, the weight of a body, the velocity required to be imparted to it, and the time allowed for imparting this velocity, we can calculate the amount of force required by the formula:

$$F = \frac{W \times V}{T}$$

in which

F = Force of inertia in force units.
W = Weight of body in pounds.

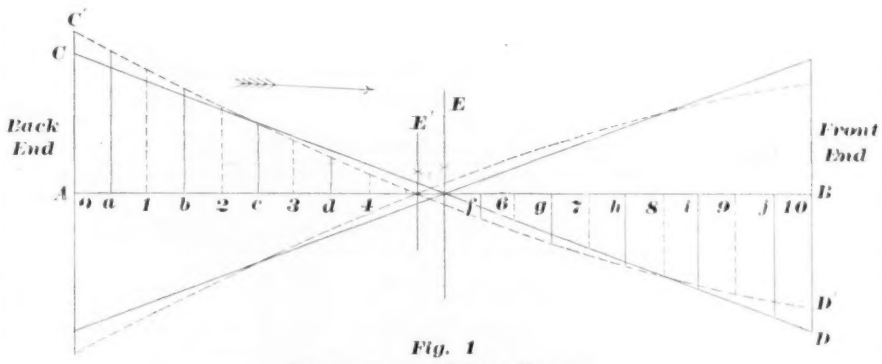


Fig. 1
FORCE IN THE STEAM ENGINE.

T = Time in seconds.
V = Velocity in feet per second.

In order to have a standard for measuring this kind of force, the force unit has been adopted. It is simply *that amount of force which, applied to a body weighing one pound, for one second, would give it a velocity of one foot per second.*

Let us consider one or two simple cases under this formula:

1. What force will be needed to give a body weighing 10 lbs. a velocity of 6 feet per second in 2 seconds? Here, $T = 2$; $V = 6$, and $W = 10$. Then

$$F = \frac{W \times V}{T} = \frac{10 \times 6}{2} = 30 \text{ force units.}$$

Any other similar case would be equally simple.

The following may seem a little different:

2. A body weighing 10 lbs. is moving with a velocity of 6 feet per second. In the space of 2 seconds its velocity is to be increased to 12 feet per second. What force will be required?

The following principle clears it up, however: It takes just as much force to give a body an additional velocity of 6 feet per second in a certain time as it does to start it from a state of rest and give it that velocity in the same time. Accordingly, the problem would be solved exactly like the first one, and the result would be the same—(30 force units). If we wished to add another 6 feet per second of velocity in the same space of time as before, we would proceed just as in the two last cases.

3. A body weighing 10 lbs. is moving with a velocity of 6 feet per second; it is required that it be brought to rest in 2 seconds. What will be the inertia force given out by the body? This problem would be solved exactly like (1), and is evidently the same thing, simply reversed. The following is the reverse of (2), and would be solved the same.

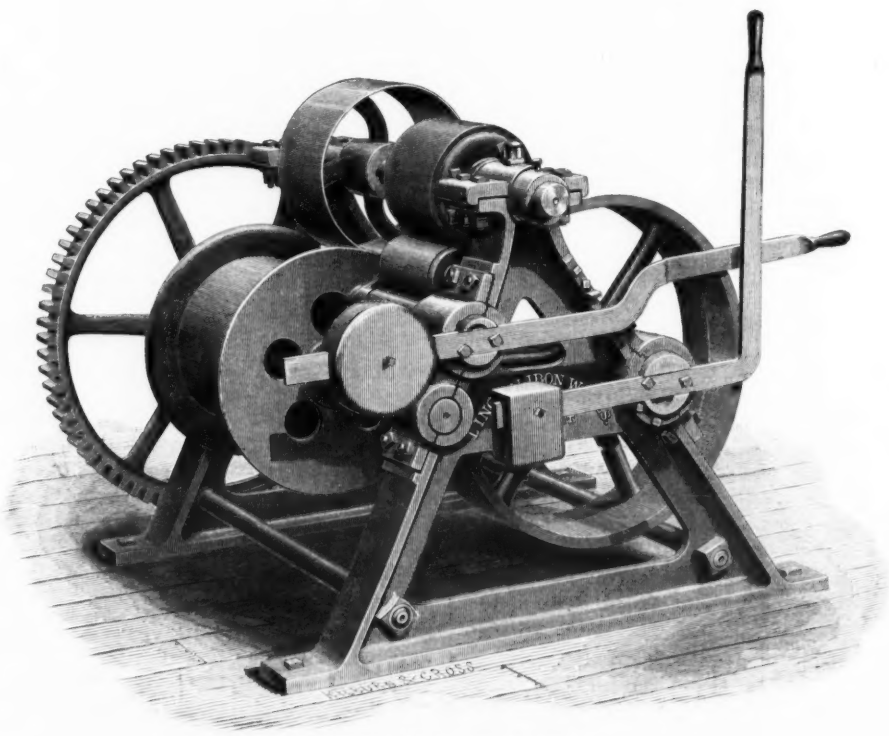
4. A body weighing 10 lbs. is moving with a velocity of 12 feet per second. Its velocity is to be reduced in 2 seconds to 6 feet per second. What will be the inertia force given out?

The solution would be the same as before.

The first two cases illustrate very well the kind of problems we meet at the head end of forward stroke, and the last two those at the crank end. We have then to trace the magnitude of inertia through the piston stroke. Since, as we have seen, the piston speed is variable, the only way we can approach a true solution is to divide the piston stroke into a certain number of parts, and proceed to determine the average inertia force for each of those parts. By taking quite a large number of divisions we can make our work very accurate, but commonly it will do to divide the stroke into ten spaces. The average force found for each space will be measured off on a line drawn perpendicular to the stroke line, and through the center of that division of the stroke for which the inertia was determined. When this has been done for all ten of the divisions a line drawn through the outer ends of the perpendiculars will give the inertia curve, as shown in Fig. 1.

In order to calculate the inertia force for any one division of the piston stroke, we must know three things: First, the weight of the reciprocating parts in pounds; second, the velocities of the piston in feet per second, at the beginning and ending of that division; and third, the time in seconds occupied by the piston in passing over that division.

The first problem will be to find the velocities of the piston in feet per second at eleven equi-distant points in the stroke. This will be the subject of the next paper. I hope no stitches have been dropped so far. If any one is keeping track of these papers, and will point out anything that has not been made clear, I will be very grateful for the suggestion, and will do my best to profit by it. My object in writing is not to teach experts, but to lay good foundations for study for some who may wish to know more of the way force acts in the steam engine. If one engineer finds his ideas any clearer, after reading these papers, I shall be satisfied.



FRICTION HOISTING POWER.

Friction Hoisting Power.

In the marble and stone mills of the country are many places where a machine for hoisting, or hauling light loads, and which can be driven by a belt from any convenient shaft, has become a necessity.

The machine illustrated herewith is built especially for this purpose. It is compact and strong, and very easy of operation. There are two levers which are counterweighted; one lever moves the large friction wheel up and against the small friction, which is made of a specially prepared friction paper, having excellent wearing qualities.

The large friction wheel is keyed to a shaft, one end of which runs in an eccentric box, to which is fastened one of the levers; on the other end of this shaft is the pinion, which gears into the large gear shown at the left in cut.

The other lever is fastened to another eccentric, in which is a stud. This stud carries two arms, and these arms carry a small shaft, on which is another friction. When this lever is up the small friction simply rests on the large friction wheel, but when the handle of the lever is depressed the small friction is brought into contact with the revolving friction at the top of the machine, and this reverses the motion, thus uncoiling the rope.

The other lever, the one bent to a right angle, when pulled toward the operator raises the large pulley to the friction at the top. When released, the weight throws it back against the stop, when used for hauling; but when used as a hoist it throws the pulley against a brake-block, placed on the bottom of the inside of the frame (not shown in cut).

The machine illustrated weighs 2,300 lbs., and will raise four to five tons on a single line, and, by using a three-parted sheave-block, will lift eight to ten tons.

These machines are manufactured by the Lincoln Iron Works, Rutland, Vt.

The Use of Compressed Air in the Cupola.

An important experiment for applying compressed air direct to a cupola furnace, for the melting of iron for casting purposes, was successfully carried out recently by the Birmingham Compressed Air Power Company. The experiment, which induced the attendance in Birmingham of nearly forty members of the South Staffordshire Institute of Engineers, took place at the iron foundry of Messrs. J. Cartwright and Sons, in New Bond street, and was superintended by Mr. Locock, resident engineer of the company. Messrs. Cartwright state that, in the melting of five tons of iron, they saved one and a half hours in time, and they estimate that an economy of 40 to 50 per cent. will be effected in the cost of the process of melting. By the application of the air direct to the furnace, the engine, and consequently the engineer, are dispensed with, and the apparatus can be regulated by the men in charge of the cupola, the danger of accident from the use of steam boiler or of the machinery being avoided.—*Ironmongery.*

In an invention relating to wheels for traction engines, made by Boulton, Ashton-upon Tyne, England, wooden blocks are inserted in the face of the wheel, these blocks resting upon a cushioning material. This, it is said, effectually avoids the jar and shock incident to the running of such engines.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SEVENTY-EIGHTH PAPER.

Side-rod Bolts. In the consideration of the strength of the bolts which fasten the straps to the main rods, we have seen that the principal force to which these bolts are subjected is a shearing force. In determining the number and diameter of these bolts we made their cross-sectional area proportional to this force, with certain allowances for the other forces to which they are subjected. It was further seen that for the light main rods two bolts through each strap are sufficient for the work they have to do; but that for the heavy class of main rods three bolts through each strap must be used, so as to obtain the required cross-sectional area, and at the same time avoid the use of bolts of excessive large diameters; or, we may say, bolts whose diameters are out of proportion to other parts of the rod.

But now, in the consideration of the strength of bolts required to hold the straps to side rods, it may be stated, at once, that more than two bolts through each side-rod strap are not required, because two bolts will always give us a sufficient cross-sectional area without using bolts of excessive large diameters. Even in the heaviest locomotives, which up to the present time have been built, it has been found that two bolts through the side-rod straps are sufficient to resist all the forces to which they are subjected, and yet the diameters of these bolts did not appear to be too large, or, in other words, the bolts did not require so much metal to be drilled out of the straps as to increase the thickness of the wings of the straps to an unreasonable extent. Of course, for practical reasons which are obvious, less than two bolts through each end of the side rod cannot be used. Therefore we may say that the number of bolts through each side-rod strap (namely, two), for any locomotive, is established. In order to find the diameter of bolts for side-rod straps, we should know the exact magnitudes of the forces to which they are subjected; but to determine the magnitude of these forces accurately is impossible; in fact, the same remarks made in relation to forces to which the side-rod straps are subjected, are also applicable to the forces which tend to break the bolts through the straps. We must therefore again allow experience to guide us in forming the following rules:

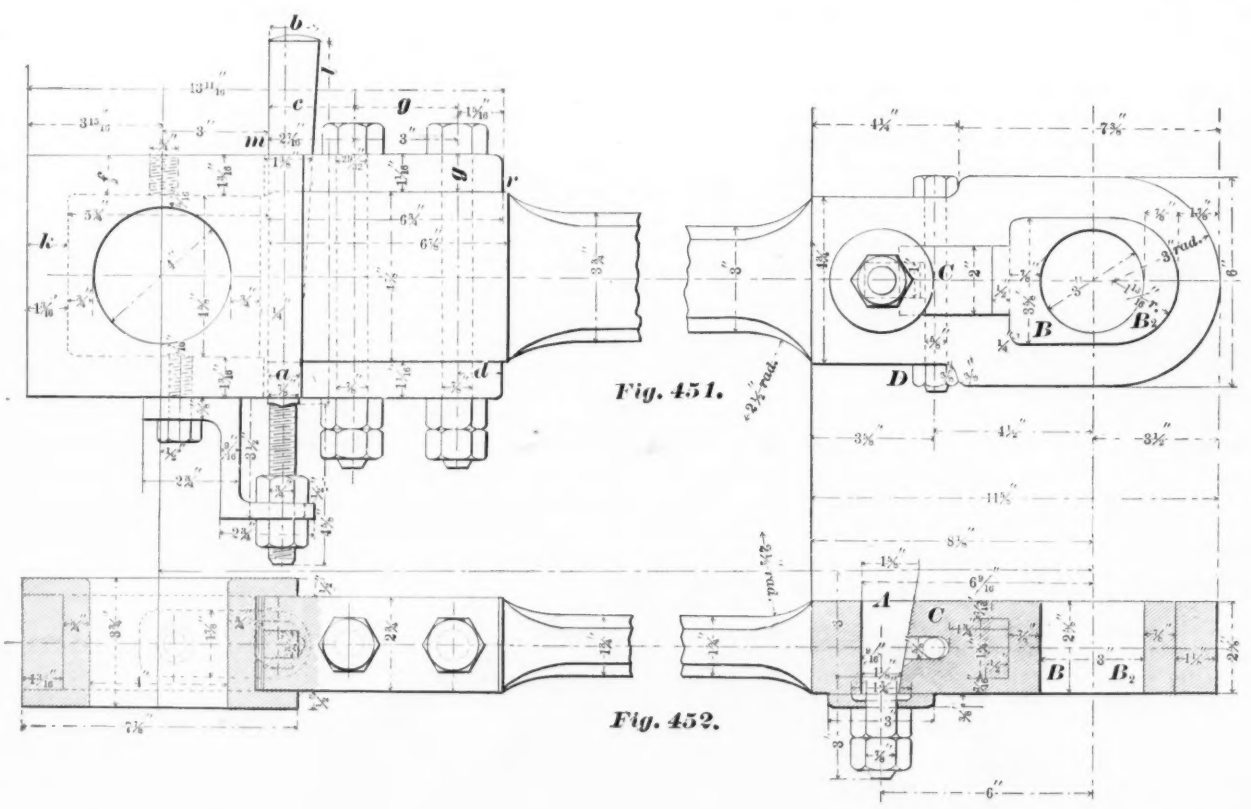


Fig. 451.

Fig. 452.

For all practical purposes we may proceed in our calculations for finding the diameters of the side-rod strap bolts, as if these bolts were only subjected to a simple shearing force, and to forces due to uneven tracks, loose boxes, curves, etc.

Therefore, in the following calculations we shall simply find, first, the diameter of the bolts required to resist a shearing force, and then add to this diameter a certain amount to allow for the forces due the unevenness of tracks, loose boxes, etc., which sum will also be sufficient for the stress due to the centripetal acceleration.

Let us first consider the diameters of bolts required for side-rod straps in eight-wheeled passenger engines. We have already seen that, in this class of engines, there are two driving wheels on each side, and that the motion to the rear driving wheel is transmitted through the side rod, which connects the two. Now let us assume, as we have done before, that the whole steam pressure on the piston is utilized in giving motion to the wheels. Under this assumption, the force acting in the direction of the length of the side rod will be equal to one-half the total maximum steam pressure on the piston, and will represent an assumed shearing force, to which the bolts are subjected.

Now, having established, for the purpose of our calculations, a shearing force, we next determine an area proportional to this force, and this may be done in a manner similar to that adopted for finding cross-sectional area of the main-rod strap bolts, namely, divide the pressure on the side rod, which, in this case, is assumed to be equal to one-half of the total maximum steam pressure on the piston, by 8,000; the quotient will give us an area proportional to our assumed shearing force; but since this assumed shearing force is greater than the actual shearing force, we have also made, to great extent, an allowance for the force due to the centripetal acceleration. For the sake of brevity, hereafter we shall refer to this area as a simple shearing area, and the force to which it is proportioned, the shearing force. Having found the required shearing area, the cross-sectional area of one bolt is readily found. Since in all side-rod straps two bolts are used, and since the shearing force tends to cut each bolt in two places, it follows that the shearing area must be equal to four times the cross-sectional area of one bolt; hence we divide the former area by 4; the quotient will be the cross-sectional area in inches of one bolt; the diameter corresponding to the last area will be the diameter of the bolt required to resist the shearing force. In order to allow for the forces due to uneven tracks, etc., we must add $\frac{1}{8}$ of an inch to the diameter thus found; the sum will be the required diameter of the side-rod bolts in eight-wheeled passenger engines. This rule can be stated in a simpler manner, as we shall presently show.

In mogul and ten-wheeled engines we have three driving wheels connected on each side of the engines; we therefore divide one-third of the maximum steam pressure on the piston by 8,000; the quotient will be the shearing area in square inches; dividing this area by 4, we again obtain the cross-sectional area of one bolt, the diameter of which must also be increased by some given amount, to resist the additional forces which come into play. This additional amount will be given in the rules which are to follow.

The diameters of the bolts through side-rod straps in consolidation engines are found in a manner similar to the foregoing. In these engines we have four wheels, connected on each side, consequently we divide one-fourth of the maximum steam pressure on the piston by 8,000, so as to obtain the shearing area; dividing the latter by 4, we obtain the cross-sectional area of one bolt, whose corresponding diameter must again be increased by a certain amount, as will be given in the following rules:

Rule 60. To find the diameter of a side-rod-strap bolt for an eight-wheeled passenger engine. Divide the total maximum steam pressure on the piston by 64,000; the quotient will be the cross-sectional area of one bolt required to resist the shearing force.

To the corresponding diameter of this area add $\frac{1}{8}$ of an inch; the sum will be the required diameter of the bolt.

Example 93. The diameter of a cylinder in an eight-wheeled passenger engine (such as is shown in Fig. 1) is 18 inches; maximum steam pressure per square inch of piston, 120 pounds; find the diameter of the side-rod bolts.

The total maximum steam pressure on the piston is equal to its area multiplied by 120. The area of an 18-inch piston is equal to 254.47 square inches; and $254.47 \times 120 = 30{,}536.4$ pounds.

$$\frac{30{,}536.4}{64{,}000} = 0.477 \text{ of a square inch.}$$

The nearest diameter of a bolt corresponding to a cross-sectional area of 0.477 square inch is equal to $\frac{55}{88}$ inch; neglecting the $\frac{1}{88}$ of an inch and adding $\frac{1}{8}$ of an inch to the diameter found, we have $\frac{5}{8} + \frac{1}{8} = \frac{7}{8}$ inch, which is the required diameter of the side-rod strap bolts for eight-wheeled passenger engines.

Rule 61. To find the diameters for the side-rod strap bolts in a mogul engine. Divide the total maximum steam pressure on the piston by 96,000; the quotient will be the cross-sectional area in square inches of one bolt necessary to resist the shearing force. To the corresponding diameter, which we designate by the letter *A*, add $\frac{1}{8}$ of an inch; the sum will be the required diameter of the bolts through the straps around the front and rear crank-pin. Again, to the diameter *A* add $\frac{5}{8}$ of an inch, the sum will be the required diameter for the bolts through the straps around the central or main crank-pin.

Example 94. Find the diameters for the side-rod bolts in a mogul engine, having cylinders 19 inches in diameter; maximum steam pressure per square inch of piston, 120 pounds. The area of a 19-inch piston is equal to 283.53 square inches; the total maximum pressure on the piston will be equal to $283.53 \times 120 = 34{,}023.6$ pounds.

$$\frac{34{,}023.6}{96{,}000} = 0.354 \text{ of a square inch.}$$

The nearest diameter corresponding to an area of 0.354 square inch is equal to $\frac{11}{16}$ inch. Therefore $\frac{11}{16} + \frac{1}{8} = \frac{13}{16}$ inch, which is the diameter for the bolts through side-rod straps around the front and rear crank-pin. And $\frac{11}{16} + \frac{5}{8} = 1\frac{1}{16}$ inch, which is the diameter of the bolts through the side-rod strap around the central or main crank-pin.

Rule 62. To find the diameters for the side-rod strap bolts in a consolidation engine. Divide the total maximum steam pressure on the piston by 128,000; the quotient will be the cross-sectional area in square inches of one bolt necessary to resist the shearing force. To the corresponding diameter, which we shall designate by the letter *B*, add $\frac{5}{8}$ of an inch; the sum will be the required diameter for the bolts through the straps around the front and rear crank pins. Again, to the diameter *B* add $\frac{1}{2}$ inch; the sum will be the diameter of the bolts through the straps around the second and third crank-pins.

Example 95. Find the diameters for the side-rod bolts in a consolidation engine having cylinders 20 inches in diameter; maximum steam pressure per square inch of piston, 120 pounds.

The area of a 20-inch piston is equal to 314.16 square inches; the total maximum steam pressure on the piston will be equal to $314.16 \times 120 = 37{,}699.2$ pounds.

$$\frac{37{,}699.2}{128{,}000} = 0.294 \text{ of a square inch.}$$

The nearest diameter corresponding to an area of 0.294 square inch is equal to $\frac{5}{8}$ inch. Therefore $\frac{5}{8} + \frac{3}{8} = 1$ inch, which is the diameter for the bolts through the straps around the front and rear crank-pins. And $\frac{5}{8} + \frac{1}{2} = 1\frac{1}{8}$ inch, which is the diameter for the bolts through the straps around the second and third crank-pins.

The bolts through the side-rod and also through the main-rod straps should be placed as close to the keys as possible, leaving only sufficient room to tighten the nuts. The distance *d*, Fig. 449, or Fig. 451, that is, the distance from end of the wing of the strap to the first bolt, is generally made equal to about one and a half times the diameter of the bolt. The distance from center to center of bolts varies from 2 to 3 inches, depending on the diameters of bolts; for engines with cylinders 16 inches in diameter and upwards, this distance is generally equal to 3 inches, and for engines having cylinders 10 or 11 inches, it is 2 inches, and in some cases even less than that. Good practice seems to indicate that these bolts should be as close to each other as a sufficient clearance for the screw wrench will allow.

The side-rod bolts are generally tapered, the taper varying from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in 12 inches. The diameters of the bolts found in the foregoing calculations are the small diameter.

Keys. The cross-sectional area of the keys is usually rectangular. We believe the better practice will be to round off the side *a*, as shown in Figs. 449, 450, because it has been found that, when keys of rectangular cross-section are used, the strap is liable to crack, as indicated at *p*, in Fig. 450, which shows that sharp corners at these points impair the strength of the strap.

The thickness of the key is generally made from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch less than the diameters of the bolts. The width *a* at the small end of the key (Figs. 449, 451) varies from one to one and a half times the diameter of the bolts; the latter is preferable for main rods, the former for side rods. The length *l* of the key is usually made equal to one and a half times the total width of the strap.

The taper of these keys varies from $\frac{5}{8}$ to $1\frac{1}{4}$ inch in 12 inches; the former is the most common.

Although sometimes the keys are made of

wrought-iron, the best practice is to make them of steel.

Figs. 451, 452 represent a main rod whose front end is designed to connect to a crosshead working between two slides, similar to the one shown in Figs. 241, 243. The key in the front end is inserted horizontally, because there is not sufficient room between the projecting ends of the crosshead to place the key vertically. The key is necessarily made short, so as to clear other parts of the machinery. It bears against a cast-iron block, which, when the key is drawn in, forces the brasses B_1 B_2 against each other. The bolt D simply prevents the cast-iron block from slipping out of position.

Disconnecting Device for Eccentric Rods.

Most engineers having experience with engines provided with disconnecting devices for the eccentric rod, have at times had more or less trouble with them, either from the fact of their wearing loose so as to produce lost motion and noise; or difficulty of connecting and disconnecting, especially in the case of large engines; it usually being necessary to use both hands, one to work the locking device and the other to lift the rod. Then there is usually a liability of a failure to connect just at the time desired.

The accompanying illustrations show a device, the makers of which have studied to provide a complete and practical remedy for these difficulties, and to provide a mechanism in which the necessity for lifting or otherwise handling the rod is obviated; in which all the manipulations may easily be effected with one hand and at one motion, without the liability of "flying out," or failure to connect.

Fig. 7 is a perspective view of the device as it appears running; the other figures being reduced copies of working drawings sent us by the makers.

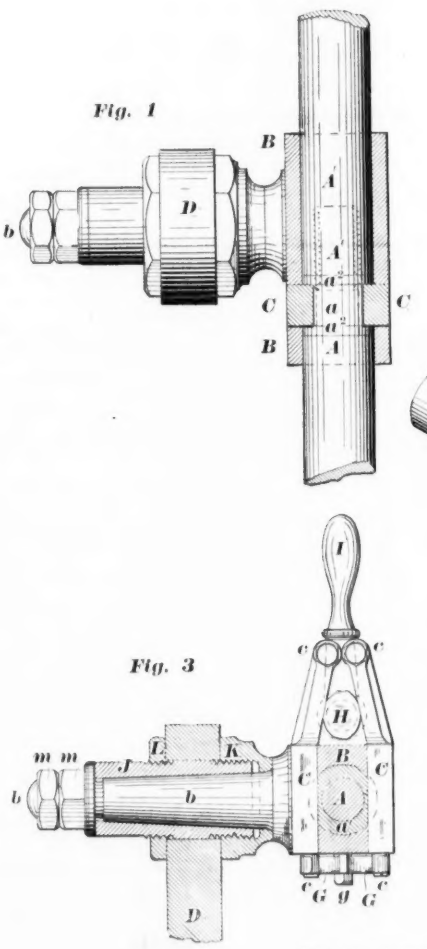
Similar letters refer to the same parts throughout. D is a part of the wrist plate or rocker arm to which the device is attached, and A is the eccentric rod, which, when the valves are being worked by hand, slides back and forth through the rectangular block B, in which it is a working fit. On opposite sides of the rod are slots shown at a, Figs. 1 and 5. On opposite sides of the block B are openings which pass from top to bottom and cut into the hole in which the rod fits. In these openings are placed the two keys C C, which are pivoted at the top of the extension F at c c. Between these keys is the cam H, which is turned by the hand lever I. When turned into the position shown in Fig. 3, the cam allows the keys to approach each other and engage with the slots a. This they do by the action of the springs G.

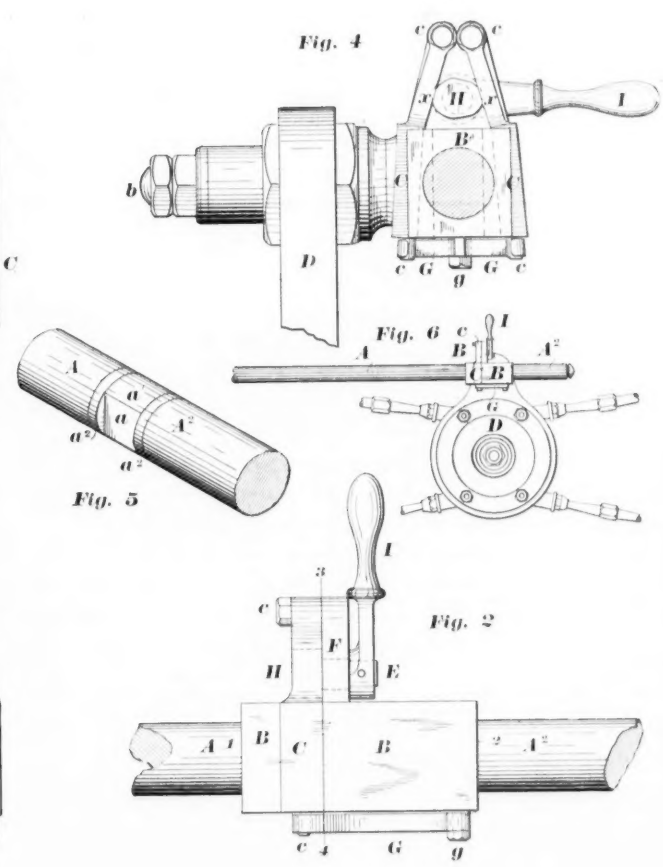
When the cam is turned into the position shown in Fig. 4, it separates the keys, forcing them out of the slots and allowing the rod to work through the block without imparting motion to the valve. The rod is made in two parts, as shown in Fig. 1, the parts being screwed together in such a way as to admit of the use of two hardened steel washers a_2 a (Figs. 1 and 5) against which the keys, which are also of hardened steel, bear. The form of bearing in the wrist plate or rocker arm is shown in section by Fig. 3, where b is the taper shank which is part of the block B, and works in the sleeve J, which is bored to fit it, passes through the plate and is threaded externally on each side. By loosening the nut L, this sleeve can be drawn through as far as may be necessary to take up all lost motion; when, by tightening L, it is made secure.

This adjustment, it will be noticed, does not change the distance of the hole in the block from the face of the plate. The nuts m m serve to take up end play of the stem in the sleeve. They are made entirely of steel, with the exception of the parts J, K and L, composing the adjustable bearing, which are of composition, selected for its wearing qualities.

It is thus seen that all that is necessary to disconnect the rod is to depress the hand lever, and in making the connection it is only necessary to raise it to a vertical position, when the keys will snap into place as soon as they come fair with the slots in the rod; and in neither operation is it necessary to use both hands, even in the case of the largest engines; while all lost motion resulting from wear can be taken up, and the rod cannot become displaced, since it never leaves its position in the block.

Fig. 7.





DISCONNECTING DEVICE FOR ECCENTRIC RODS.

The Effect of Oil on Steam Engine Valves.

In the discussion which followed the reading of Prof. R. H. Thurston's papers on Internal Friction, Engine Speed, Work, etc., at the Scranton meeting of Mechanical Engineers, W. E. Crane said:

Prof. Denton speaks of water in steam being a lubricant. Some years ago a 30x60 Corliss engine was erected, and supplied with steam through a 10-inch pipe over 200 feet long. The engine was started up and run for nearly a month with uncovered pipe. During this time it required a large amount of cylinder oil. The pipe was finally covered, and the amount of oil required was materially reduced.

After some four years, it became necessary to replace this pipe with a new one, and while the new pipe remained uncovered there was the same difficulty of properly lubricating the cylinder, which difficulty was removed by covering the pipe.

Of course the condensation was very great in the uncovered steam pipe, and showed that the presence of water in the steam required more oil for lubrication.

Prof. Denton also mentions the fact that, where steam is cut off short, more oil is required than when the cut-off is later. If we could entirely prevent cylinder condensation, the problem of cylinder lubrication would be much simplified, and if there were no re-evaporation no more oil would be required with a short cut-off than with a long one.

Some one has claimed that oil is not needed in a cylinder, and as proof of such statement mentions the fact that many engines have been run for years where it was not possible to get oil in the cylinder.

It is true that engines were so run, but it is equally true that the friction in the same was very great. This might be illustrated by a homely incident.

On the old style of locomotives they used a plain slide valve for throttle valve, and to make these throttle valves work easier, an oil cup was placed in the dome just over the steam pipe, with a small pipe leading down to it. It was the duty of the fireman before any pressure was raised to pour some oil down this cup and pipe, which oiled the throttle valve. Should this small oil pipe become knocked one side, the oil would go into the boiler instead of the steam pipe.

A locomotive was sent to do duty on a branch road, and the engineer, fearing that this oil pipe might have become displaced, would not allow the fireman to put any oil in, for fear of its going into the boiler and cause foaming.

The fireman, having all the switching to do, was anxious that the throttle should work easier, and one morning he disobeyed orders and poured some oil into the cup. When he started the machine out of the house he saw that the throttle was all right, but thought he would let the engineer find it out himself. The train was made up and the signal given. The engineer, according to his usual custom, braced his feet and took hold of the handle with both hands, and pulled with all his strength.

The resistance by friction having been nearly all eliminated by the oil, the handle straightened out, and the engineer found himself back in the tender.

The Russian Cruiser "Admiral Korniloff."

The new Russian cruiser "Admiral Korniloff," which has been built at St. Nazaire by the Société des Ateliers et Chantiers de la Loire, has just completed her trials off Cherbourg. The "Admiral Korniloff" is, says the London *Times*, a cruiser built partly of steel, partly of timber, with twin screws, and has a displacement of 5,000 tons. Her principal dimensions are 350 feet in length by 48 feet broad, and her draft of water does not exceed 23 feet, so that she can enter almost any port. Her armament consists of fourteen 6-inch guns, of a very new pattern, and all well protected from the enemy's fire, ten revolver guns, six guns with rapid fire, two guns for using in the ship's boats, and six torpedo tubes. The motive power consists of two horizontal engines, with triple expansion, each driving one of the screws, while there are eight boilers, and four ventilators, which will keep the temperature of the engine rooms to within 86 degrees. The "Admiral Korniloff" will carry enough coal to enable her to steam 15,000 knots at a moderate speed, so that she would be able to go from the Baltic to China without putting in to coal at any port. The vital parts of this cruiser are protected by an iron-clad deck, while the sides are also well covered, and the coal bunkers will act as a protection for the engines and machinery. The commander's post, in the event of a combat, is a large iron-clad block-house, in which are concentrated all the cruiser's means of action, such as the wheels of the helm, the apparatus for transmitting orders to the engine rooms and powder magazines, and also the apparatus for the converging of artillery-fire and the discharge of the torpedoes. In short, this block-house contains all that the commander of the cruiser, aided by a few of his officers, would require for the management of his ship if engaged in combat. The accommodation for both officers and men is very spacious and comfortabie, and the crew numbers over 400. The trials took place with the cruiser carrying a full cargo, and with her bunkers full of coal, the artillery being represented by an equal weight of ballast. The first trial, which lasted over six hours, resulted in the mean speed of 17½ knots, while a second trial, at high pressure, gave 18¼ knots. The "Admiral Korniloff" has been two years in building, and her commander and officers are said to be much pleased with her.

A company has been formed in France, headed by a well-known Alsatian manufacturer, for the purpose of diverting the Guiers river to St. Christophe, where a fall of 200 meters would be thus obtained, representing a force of 4,000 horse-power, which would be utilized in developing electricity for the production of aluminum by a new process from the clay found in the district. It is asserted that by means of the process in question, aluminum, which is at present so costly, can be produced at a price that will very little exceed that of the cheapest metals.

Consequent upon the more extensive use of hydraulic power in connection with the loading and unloading of the fleet of steamers at Holyhead, a large number of men who are employed upon the wharves of the London and Northwestern Railway have received notice that their services are to be dispensed with. It is understood that great reductions are contemplated in the crews of the steamers employed in the Irish service, most of which are now screw steamers.—*The Mechanical World.*

Notes on the Expansion of Steam.

By RICHARD H. BUEL.

THIRTEENTH PAPER.

[This paper, through an oversight, was incomplete as published last week; hence its republication as completed.]

The effect of attaching a condenser to a non-condensing engine is to decrease the back pressure. Assuming that the back pressure is reduced to $1\frac{3}{4}$ pounds per square inch, and that the friction pressure and pressure required to operate the air pump of the condenser amount to $2\frac{3}{4}$ pounds per square inch of effective piston area, the total back pressure will be $4\frac{1}{2}$ pounds per square inch, instead of $17\frac{1}{2}$, as in the case of the non-condensing engines, already considered. But since the temperature to which the internal surfaces of the cylinder are subjected at each stroke is lowered by the use of a condenser, the hourly condensation on these internal surfaces is usually increased; and in the present discussion it is assumed that each square foot of internal surface condenses 25 pounds of steam hourly, instead of 15, as before.

By making these two changes in the assumptions, the general formulas published in the AMERICAN MACHINIST for June 30, 1888, become available for condensing engines. The results calculated from the formulas are given in Table *G*, each line containing a reference number to the formula used.

It will be seen, by comparing the figures in line 57 with the figures in the same line for non-condensing engines, that the economy at points of short cut-off is greatly increased, principally on account of the reduction in back pressure, the modifying effect of which was discussed in the first article of this series. Of course, this reduction in back pressure increases the effective horse-power to a considerable extent, over the corresponding cases for non-condensing engines, the increase being especially marked at the shortest cut-offs. It may be a question in the minds of some readers, whether as much economy would be shown over the non-condensing engines if the same effective horse-power were developed in each instance. This can readily be determined by calculating the results under the last supposition. Table *H* contains the calculation, in an abbreviated form, from the formulas of the general table, with references in each instance to those formulas; all necessary data for the solution being supplied, but some of the intermediate steps being omitted. By the aid of the formulas published June 30, 1888, the reader can follow the calculations in Table *H*, and can easily supply the intermediate steps of the problem.

It will be seen that the economical results, line 57, Tables *G* and *H*, do not differ greatly, for similar points of cut-off; and it may be interesting to check the theories and assumptions introduced into the calculations by an examination of some practical results. Table *I* is compiled from the record of experiments made with an automatic cut-off engine, measuring the effective horse-power on a friction brake; and a comparison of the figures in the last column of this table with corresponding figures in line 57, Tables *G* and *H*, indicates that the assumptions agree fairly with good practice.

G.—Theoretical Results of Using Steam Expansively. Condensing Engines, Dry Saturated Steam, Unjacketed Cylinders. (The Numbers in the Third Column refer to the Formulas published in the AMERICAN MACHINIST, *June 30, 1888.)*

Item.		Symbol.	Formula.	Point of Cut-off. Full str'ke	3/4	1/2	1/3	1/4	1-6	1/8	1-12
Mean pressure, pounds per square inch.	Corrected for back pressure	M	22	90.5	88.4	78.3	65.9	57.7	45.4	37.7	29.8
	Corrected for back pressure and clear'nce	N	23	90.2	88.0	77.5	64.7	56.3	43.8	36 1	28.0
Ratio of compression		l	20	1	1.318	1.935	2.813	3 655	5.228	6 833	9.464
Hyperbolic logarithm of ratio of compression		hyp log l	21	——	.2761	.6601	1.0343	1 2961	1.654	1.9218	2.2475
Final cushion pressure, pounds per square inch		L	27	4.5	5.9	8.7	12.6	16.4	23.5	30.7	42.6
Mean absolute cushion pressure, pounds per square inch		k	28	——	5.1	6.1	7.2	8.0	9.2	10.1	11 3
Mean pressure, corrected for back pressure, clearance and cushion, pounds per square inch		t	29	90.2	88.0	77.4	64.5	56.0	43.2	35 3	26.6
Probable mean effective pressure, pounds per square inch		e	30	85 7	83.6	73.5	61.3	53.2	41 0	33.5	25.3
Probable effective horse-power		(E)	39	177	178.9	180.2	188	202.3	228.6	257.3	321.9
Pounds of steam used hourly.	Calculated by piston displacement	Q	47	5883	5582	4034	3611	3506	3619	4051	4480
	Condensed for the work of expansion	(C)	52	——	124	207	294	370	477	575	704
	Condensed on internal condensing surfaces	(d)	25 (a)	473	493	560	710	863	1258	1718	2833
	Total	(w)	56	6356	6199	4801	4615	4739	5354	6824	8017
	Per effective horse-p'r	(W)	57	35.9	34.7	26.6	24.5	23.4	23.4	24.6	24.8

H.—Theoretical Results of Using Steam Expansively, Condensing Engines, Dry Saturated Steam, Unjacketed Cylinders, 150 Effective Horse-Power, 100 Pounds Initial Pressure, 4½ Pounds Back Pressure.

Item.		Symbol.	Formula.	Point of Cut-off. Full str'ke	3/4	1/2	1-3	1/4	1-6	1/8	1-12
Trial data.	Mean effective pressure	T	13	90.5	88	77.7	64.1	54.5	41.8	34	24.8
	Cross section of cylinder, square inches	a	15	121.55	125	141.57	171.61	201.84	263.16	323.53	443.55
	Diameter of cylinder, inches, to nearest 1/4"	d	16	12½	12½	13½	14¾	16	18¼	20¼	23¾
	Stroke, inches	s	17	25	25	27	29½	32	36½	40½	47½
	Fraction of clearance	F	18	.0375	.0400	.0394	.0381	.0311	.0355	.0340	.0355
Per cent. of clearance to nearest 1/4"		c	19	3¾	4	4	3¾	3¾	3½	3½	3½
Real ratio of expansion and ratio of compression		R. l	20, 24	1	1.3165	1.9259	2.7978	3.6087	5.1322	6.4687	8.7465
Hyperbolic logarithm of preceding		hy log R	From tabl's	——	.2753	.6554	1.0289	1.2834	1.6355	1.867	2.1686
Probable mean effective pressure		e	30	85.6	83.4	73.6	61.4	52.7	41.2	34.4	25.8
Diameter of cylinder, inches, to nearest 1/4"		D	34	13	13¾	14	15¼	16⅛	18½	20¼	23½
Stroke, inches		S	35	26	26½	28	30½	33	37	40½	47
Diameter of piston rod, inches, to nearest 1-16"		p	36	2 5-16	2¾	2½	2¾	3	3 5-16	3⅜	4¼
Cross-section of cylinder, square inches	Actual	(A)	37	122.73	137.89	153.94	182.65	213.83	268.8	322.06	433.74
	Effective	(q)	38	130.63	135.67	151.48	179.68	210.29	264.49	316.9	426.64
Probable effective horse-power		(E)	39	152.5	154.3	152	150.4	151.1	148.6	148.7	150.1
Volume, cubic feet.	Cylinder and clearance, up to 95-100 stroke	v	42	.941	.06	2.43	3.132	3.966	5.578	7.316	11.309
	Clearance	N	41	0737	.0832	.0982	119	.151	.198	.26	.402
Absolute pressures.	Final cushion	L	27	4.5	5.9	8.7	12.6	16.2	23.1	29.1	39.4
	At 95-100 stroke	B	44	91	73.8	51.8	36.2	28.4	20.1	16	11.9
Number of strokes per hour		w	43	12752	12226	11571	10623	9818	8759	8000	6968
Weight of steam per cubic foot, pounds	At pressure *L*	w	From tabl's	.01249	.0161	.02319	.03285	.04159	.05805	.07211	.09586
	At pressure *B*	W		.2107	.173	.124	.08603	.07048	.05093	.04111	.03113
Pounds of steam hourly, calculated by piston displacement		Q	47	5303	4330	3460	2821	2683	2387	2256	2185
Latent heat per pound of steam at pressure *B*. British thermal units		(l)	From tabl's	——	899	916	931	941	955	963	973
Pounds of steam condensed hourly for work of expansion		(C)	52	——	106	194	249	281	313	339	390
Thickness of piston, inches, to nearest 1/2"		(T)	53	3½	3½	3½	4	4	4½	4½	5
Internal condensing surface, square feet		(a)	54	16.3	16.9	18 8	22.4	25.8	32.8	39.1	52.1
Probable condensation, hourly, on internal surfaces, pounds		(d)	25x(a)	408	424	471	561	645	819	976	1304
Probable consumption of steam, hourly, pounds.	Total	(w)	56	5611	4860	4125	3631	3609	3519	3571	3879
	Per effective horse power	(W)	57	36.8	31 5	27.1	24.1	23.9	23.7	24	25.8

I.—Experiments Made with a Condensing Engine, Unjacketed Cylinder, Using Dry Saturated Steam.

Number of Experiments.	Diameter of Cylinder, Inches.	Stroke, Inches.	Per Cent. of Clearance.	Absolute Initial Pressure, Pounds per Square Inch.	Apparent Cut-off.	Piston Speed, Feet per Minute.	Effective Horse-power.	Pounds of Steam Hourly per Effective Horse-power.
1	22	43 5	3.7	70.8	.09	431	88.3	24.7
2				100.6	.14	421	144	24.3
3				99.8	.18	429	161.2	24.6
4				76.2	.25	429	156.3	22.4
5				63.6	.29	431	133.9	24.4
6				46.8	1	435	159.5	40.9

Space for American Exhibitors at Paris.

We are in receipt of a communication from the United States Commission to the Paris Exposition of 1889, calling attention to the short time yet remaining for those intending to exhibit there, to secure space. The allotment of space takes place on Nov. 15th, and shipments by steamer begin in January. The amount of space allotted to the United States is being filled up by applicants from all parts of the country. The Commissioners are progressing with their work on a basis of absolute impartiality. It is simply a case of first come first served. From present indications, it is not unlikely that many manufacturers who are now hesitating, will find themselves in the position of the foolish virgins, unless they make application for space without further delay. According to the provisions of the French Government, there is to be no charge for space occupied by exhibitors. Moreover, as it is the intention of the United States Government, in participating in this exposition, to demonstrate the merit and comparative excellence of our products and manufactures, the commissioners will forward, free of freight between New York and the Exposition, going and returning, all articles received for exhibit.

The exhibition is to be divided into nine groups, the fifth, devoted to "The raw and manufactured products of mining, forestry, chemistry, etc.," and the sixth devoted to "Apparatus and methods of mechanical industries."

It will be remembered that Hon. Perry Belmont, in submitting the report of the Committee on Foreign Affairs, urged the acceptance of the invitation to exhibit, upon economic and patriotic grounds, and that an appropriation of $250,000, was granted by Congress to defray expenses. There is no charge to exhibitors either for space in the exhibition or for freight charges to and from it.

We are requested to urge upon our readers the advantages of an exhibit, and the importance of making immediate application for space.

All communications must be addressed to the Commissioner-General, William B. Franklin, or to the Assistant Commissioner-General, Somerville P. Tuck, whose offices are in the Washington Building, No. 1 Broadway, New York.

An Electric Dog-cart.

Ironmongery, with an illustration of an English dog-cart, thus refers to the employment of electricity as connected with motive power in England. The cart is made by Immisch & Co., Kentish Town:

* * * The power is stored in 24 electric power storage accumulators of special type, which contain a charge sufficient to propel the dog-cart for about five hours at a speed of 10 miles an hour. The motor is of Messrs. Immisch's one-horse power type, using a current of 20 amperes, with an electro-motive force of 48 volts; and it may be mentioned that when the vehicle is running at a speed of 10 miles per hour, the motor makes 1,440 revolutions per minute, and develops three-quarter horse-power. Including accumulators, the total weight of the carriage is 11 cwt. The electric apparatus is placed beneath the body of the carriage, and is so compactly arranged as scarcely to attract attention. The steering gear is quite distinct from the electric motor, and is at once simple and effective, somewhat resembling the guiding apparatus of a bicycle, though, of course, in keeping with the weight and character of the dog-cart. For this purpose, in place of the shafts, the fore-carriage is modified to carry a toothed rack. Upon this works a pinion, and a shaft passing upwards through the foot-board terminates in a steering handle under the control of whoever takes the place of the driver on the front seat of the vehicle. An ordinary foot-brake, also worked by the driver, brings the dog-cart to a stand. Both the stopping and guiding mechanism work promptly and effectively.

LETTERS FROM PRACTICAL MEN.

Quick-Return Motion—A Defense of Cast Gearing.

Editor American Machinist:

There appears to exist some insuperable obstacle to truth telling, whenever an Englishman or an American has remarks to make concerning the engineering of the rival country, and of this inability to convey truthful impressions your issue of Oct. 13th contains a good example of an American tool manufacturer who has been "loafing" in Europe, and nowhere in England "saw a quick-return motion to any planer or slotter." I fear he did loaf, and never saw the inside of a shop, for I have spent my life amongst them, and cannot say I have seen any such machine *without* such arrangement.

Concerning the scarcity of cut gears on machine tools, your informant has some basis for his remarks.

The gears of lathes—I do not, of course, refer to the screw-cutting train, but to the ordinary back gears—are very usually simply cast, and not cut, but they are cast from patterns of extremely careful make. It is, however, remarkable that the form of gear tooth adopted by machine tool makers has not always been the best, and on this point I can offer some remarks of interest.

The shop in which I was apprenticed, *and wherein all planers, etc., had quick-return gears*, was accustomed to purchase lathes from a maker of world-wide reputation in Manchester. The gears were so notoriously bad and noisy, that my employers were accustomed to ascertain the dimensions of the various gears required, and then to furnish the tool maker with patterns from which all gears were cast. In our shop the business of gear pattern making was reduced to a science. No makeshift odontograph forms were employed, nor approximate circular arcs for the profiles of teeth, but the proper curves were delineated by the rolling circle and scribing point, and the revolving cutters, which formed the faces and flanks of the teeth, were accurately shaped to these rolled curves.

With careful moulding in the sand, gears cast from patterns made from seasoned timber, and well varnished, will differ nothing from cut gears in quiet working, whilst they are more durable. Properly cast, they need no trimming, but come from the sand perfectly smooth. A cut wheel has not the advantage of the hard skin, and so deteriorates more rapidly. The above may seem bold statements to make; they could not be made if even a good pattern were moulded with no better care than is usually bestowed on a grate bar.

The dividing engine in which we cut all our gear patterns was operated by cut gears, of course, the dividing wheel having 360 teeth in a diameter of about four feet. As there was no variation measurable in the pitch of teeth, in gears as large as 22 feet cut on this dividing engine, it is tolerably certain that, in ordinary lathe gears, the patterns produced were accurate. Each pattern had the standard draft, and when geared in a machine, and the draft reversed in two engaged wheels, a full bearing can always be had.

When accurately cast gears can be obtained, it always seems a pity to sacrifice the

hard skin of the casting, and throw away such a potency of durability. This durability was brought to my notice once by the engineer of a woolen mill in Scotland, where I was once doing some piston overhauling. The large drive wheel of the engines, a pair of beams doing about 250 horse-power, was about 20 feet diameter. It had worked night and day for 17 years. Every tooth was bright as silver, and perfect in form, with no wear beyond the polishing, which had only just removed the sand roughness. Very little wheel grease was to be seen, but in stopping the engines it was the habit to bring a different part of the large wheel to an accessible position each time, and the engineer would clear away all superfluous grease and smear lightly each working face of the teeth.

Nothing looks worse than a pair of heavy gears thickly bedaubed with black grease, which is flung by centrifugal action on adjacent walls.

It is common practice to enclose such gears in sheet metal cases, but this ought never to be needed, for the amount of grease should never be so great that its adhesion to the teeth is less than its centrifugal tendency. This condition is only possible with a thin smear of grease. A guard is sometimes advisable at the gearing point, to prevent accident or the fall of foreign objects between the wheels, but no wheel looks well wholly boxed in.

Since writing the foregoing, I have chanced across an old machinist who has had over forty years' experience in different English workshops. He informs me that he has never known a planer without a quick-return motion, excepting it had a "jim-crow" tool-box, or a tool-box on each side of the tool-slide, or was otherwise arranged for cutting each way. Perhaps your informant has chanced upon several of this description, and not noticed the double cut. He has seen small slotters without quick-return, but none such with a maximum stroke of more than four inches. Asked as to his opinion of cut gears, he considered that gears cast from cut patterns were far preferable. As my aged informant was first trained as a tool maker, and has, amongst other places, worked for years at Whitworth's, you may feel certain that you have been misinformed in regard to the alleged scarcity of quick-return motions, but that cut gears apart from the screw train are exceptional.

Of one great firm of tool makers to whom I have already made reference, I am reminded of remarks often made concerning them, that they made everything perfect except wheel teeth, and of these they made the very worst in the trade.

I am fully aware of the importance attached in America to cut gears for machine tools, and have wondered at this preference for wheels of smaller durability. No foundry ought to feel that it has a title to existence, which cannot cast a perfect wheel from a perfect pattern, and dispense with the labor of cutting the teeth and losing the hard-chilled working surfaces. W. H. BOOTH.

Quick-Return Motions in Europe.

Editor American Machinist:

In your issue of Oct. 13th, I notice an account of a visit of an American machine tool manufacturer to Europe, who nowhere there saw a quick-return motion on a planer or slotter; and, on that as a basis, infers that we ought to beat other countries in open competition. Now, as your paper has a large circulation amongst a class of men who are apt to do their own thinking, and who might consequently be seriously misled by such a statement, I desire, in order that the truth may prevail, to send you some of my own impressions upon this point; and to satisfy you that I have some right to institute a comparison, I may say that, although I have been in the business here about twenty years, my visit to England extended over a longer period still.

As to the history of the quick-return motion, the records of the Royal Scottish Society of Arts show that a medal was awarded to Thos. Shanks, as the inventor, in the year 1846; and it is well known, at least in Great Britain, that Whitworth and all the other notable tool makers have used the quick-return motions of various kinds, from that time to this. I myself worked on planing machines with quick-return motions in England, nearly thirty years ago.

Concerning the general impression which prevails here, to the effect that English methods, appliances and workmen are inferior to those of this country, I wish to say that it is altogether erroneous.

Great Britain may be called conservative in her characteristics as a whole, but in the ready adoption of real improvements and labor-saving contrivances, she is at least abreast of any other country; and the very fact that some of her machinery builders make a business of copying the newest designs, line for line, from other countries, only amplifies the proof.

Taunton, Mass. J. T. M.

Soldering on Cast-Iron.

Editor American Machinist:

In a foundry doing agricultural work there are many changes to be made to patterns, and often it is desirable to solder brass to cast-iron where drilling and riveting to the pattern would make anything but a neat job. By a great many men who work on iron patterns it is considered quite a secret to solder on cast-iron, but it is not so. The process is very much the same as soldering on a tinned surface. If the part of iron to be soldered is cast-iron that is hard or thin, it should be polished on an emery wheel and made clean and bright. Then dip it in potash water, after which dip it for an instant in clear water and wash it quickly with undiluted muriatic acid of the ordinary strength; go over it with powdered rosin and solder made from half tin and half lead. This must be done quickly, before the surface has time to dry.

Another plan is this: File the surface clean and wash as before; wipe it over with a flux made of sheet zinc dissolved in muriatic acid until it is surcharged or is a saturated solution, and has been diluted with its own quantity of water; then sprinkle powdered sal-ammoniac on it, and heat it on a charcoal fire until the sal-ammoniac smokes. Dip it in melted tin and then remove and rap off the surplus tin.

Patterns that are to be canceled are better made from a cheap brass, which can be made of 12 lbs. of copper and 8 lbs. of zinc. This will make a good yellow brass that will file easy and finish smooth. There are few men that fully understand carding patterns; patterns can be carded by drilling small holes in the side of the pattern and putting small wires from one to the other, and filling in between with melted lead and then putting a strip of brass the entire length of the patterns for flowing the metal; all small work should be carded, as this is a cheap way of moulding small work.

Where a few small patterns are wanted, and wanted quickly, they can be made from 1 lb. of zinc and one of tin; this is a good metal to finish. D. SPENCE.

Tempering Knitting Needle Points.

Editor American Machinist:

In November 10th issue I see Question 490, asking advice about tempering knitting needle points. The best preparation I know of is as follows: Take equal parts of muriatic acid and water. First dissolve all the zinc the acid will take, after which add the water. Heat the steel to the proper heat and immerse in the bath, after which cool in cold water. With this preparation the temper need not be drawn. G. B. STEWART.

Dimensions on Drawings.

Editor American Machinist:

Regarding the discussion started by Mr. Rogers, about dimensioning drawings, I think one point has been overlooked in attempting to leave off any dimension, and measuring the drawing to obtain the required dimension. Most shops use blue prints, and the dimensions on these do not measure the same on these as on the original, because of shrinking after being taken from the bath; and unless paper is shrunk on board, the dimensions on that are variable, according to weather, to such an extent as to render measuring for good work worthless.

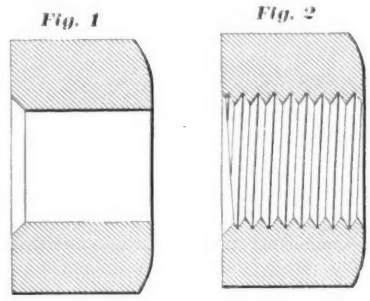
F. H. STILLMAN.

Nuts.

BY A. B. LANDIS.

How often we are annoyed with not being able to enter a bolt into a nut that has been faced on its under side by the thread having been turned in the operation of facing it, which necessitates the nut to be run onto the

Fig. 1 *Fig. 2*



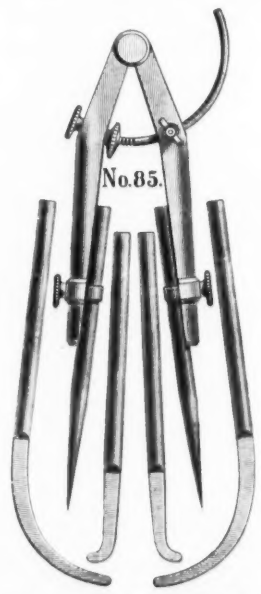
bolt the reverse way, in the vise or otherwise, to force this thread out and enable it to enter the way intended. This causes a great deal of lost time and expense.

Modern nut-facing machinery has an attachment which is intended to cut out the bruised thread, and it does the work very well, provided the cutting tool is kept very keen and sharp, so as to cause no bruising of the thread by this operation. If the facing tool were kept keen-edged this operation might not be necessary. But as a rule this work is done by boys or cheap labor, and the tools are not kept so sharp as they ought to be.

I have known, where this attachment for cutting off the thread has been used, owing to lack of proper keenness of cutter the thread was bruised in a much worse condition than it would have been if the attachment had not been used.

Could not manufacturers of nuts make them as shown in Fig. 1, with the corner sufficiently beveled off to escape the thread? Then the thread would not be disturbed in facing. This would leave the nut clear on the entering side, with no obstruction, and just as the tap left it, regardless of the facing operation. Some manufacturers ream and chamfer the nuts on the outside edge by using a beveled cutter on the reamer. This countersink could be as quickly made as to ream them, and, by a stop on the reamer, could all be countersunk the same depth.

Other manufacturers make cold-pressed nuts. Not knowing much about the manner of pressing them, would it not be possible to press this countersink into the nut, and thus furnish nuts to the trade that would avoid all the annoyance to the consumer before mentioned? The manufacturer of nuts who makes this improvement will bestow a great advantage on the consumer, with no additional cost to himself. In the absence, however, of nuts thus made, it will pay the user of nuts to take all of them before tapping, and countersink or bevel the corner on a drill press with a reamer made with a stop, to cut them to equal depth. It must be clear that this will obviate all this trouble, and, when tapped and faced, the nuts will appear as in Fig. 2.



COMBINATION DIVIDERS.

Combination Dividers.

The accompanying cut represents a divider with auxiliary caliper legs, which, together with a common pencil, may all be used interchangeably with the arms, forming useful and convenient combinations.

The points can be used as shown in cut, or by inserting the others shown, either inside or outside calipers can be had; or, by using either one of the points in connection with one of the inside caliper legs, an hermaphrodite is formed. A common pencil may also be inserted in one arm when desired.

Passing through one of the arms, and between the two knurled nuts, is a small spiral spring, which acts in the same manner, and serves the same purpose in adjusting, as the usual flat spring; but after the adjustment is completed, the inside nut is screwed up firmly against the leg, compressing the spring and making the connection between the legs rigid. The points are of steel, hardened. The tools are made in two sizes, the smallest 7 inches long. By adjustment of the points they become 9 inches, and will scribe a circle 22 inches diameter, and will caliper 11 inches outside and 13 inches inside. The larger size will describe a circle of 30 inches diameter, and caliper 14 inches outside and 16 inches inside.

They are furnished with or without caliper legs by L. S. Starrett, Athol, Mass.

Women to Whom Patents Have Been Issued.

The Commissioner of Patents, Mr. Benton J. Hall, has had prepared a list of women inventors, or women to whom patents have been granted. This list has been printed, and makes a folio pamphlet of forty-four pages. It gives not only the names of the patentees, but also the title of the patent and date of issue. The first patent issued was to Mary Kres, May 6, 1809, for straw weaving with silk or thread.

Six years later, Mary Brush obtained a patent for a corset, and then four years elapsed before another inventive woman appeared. This was Sophia Usher, whose patent was for carbonated liquid cream of tartar. Then, again, in 1822, Julia Planton secured a patent for a footstool. During the four following years a patent was issued each year to a woman, and from that time down to the present the number of women patentees gradually increased. In recent years feminine inventiveness has shown marked progress. For instance, from the 1st of January, 1888, to the 26th of June last, no less than 66 patents were issued to women, while during the year 1887 179 patents were so issued. This latter is the largest ever issued. While the names of the articles patented show that they were generally in the line of feminine wearing apparel and household labor-saving devices, yet many were of a character that shows the multiplied interests of women. As an instance, one woman patented a submarine telescope and lamp. Others were granted as follows: Improvement in reaping and mowing machines, improved war vessel, furnace for smelting ores, apparatus for punching corrugated metals, method of construction for screw propellers, low-water indicators, material for packing journals and bearings, conveyers of smoke and cinders for locomotives, burglar alarms for windows, etc.—*Washington Star.*

W. H. Booth writes us in regard to Question 464 (Oct. 27): "There was an instrument devised within the past five years for measuring the pitch of screw propellers. I believe a patent was obtained for it in England, and probably in the United States."

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Piece-Work.

The question of piece-work in machine shops is one upon which different men hold diametrically opposite views, and, as upon politics and other questions, each one is disposed to think that there can be but one correct view regarding the matter, and that is the one held by himself. The fact is that some very good arguments can be presented upon both sides of this question, and whether the system of piece-work or of day-work is best, depends a great deal upon the nature of the work to be done, but much more upon how the matter is managed.

We frequently see in advertisements of machinery, the statement that all work in the shops where it is built is done by the day; no piece-work is allowed, and consequently there is no incentive to careless and poor work. The disposition of workmen to slight piece-work, and do it in the poorest possible manner so long as it is accepted, is supposed by many to be fatal to the production of the highest grade of work. And yet it is a notorious fact, that much of the best and finest work produced in this country is paid for entirely by the piece; and the men connected with the shops where this work is done, naturally think that the system of piece-work is the correct one.

Where there is such a decided difference in opinion and practice, it ought to be possible to find a satisfactory reason for it, and the reason, as intimated above, is, we think, to be found mainly in difference of management.

Of course, it is entirely natural for men who are receiving a certain definite price for a certain piece of work, to put the least amount of labor upon it, which will make it acceptable. We may deplore or condemn this disposition as much as we choose, but that will not help the matter, because it is founded in human nature. Men do not, as a rule, work for the sake of work. Labor is not in itself desirable; it is the results or products of labor which we desire, and which constitute the sole natural incentive to labor. This universal and inherent disposition of mankind to supply their wants with the least possible exertion, which is in itself right, and to which we are indebted for all our progress and improvements, is the prime cause of slighted piece-work. But some manufacturers leave it to their customers to discover that this tendency has resulted in poor work being done, while others have men whose especial business it is to discover this before the work is accepted from the workman; and herein lies the main secret of the success or failure of the piece-work system.

Payment by the piece is undoubtedly the most fair and just system, where the work is of such a character as to admit of it, because each man is then most likely to be paid in exact proportion to his ability; but it is all-important that there should be some definite standard of workmanship which the finished work must conform to, and it is of equal importance that there should be some one to see that that standard is maintained and uniformly adhered to.

In the most fully organized shops where piece-work is done, there is such a person, called the inspector, who has nothing else to do but to apply gauges and various tests to the work as it comes from the various workmen, and reject those pieces which are not fully up to the standard. In shops not so large or so fully organized, this duty is performed by the foreman, and, in such a case, a double responsibility rests upon him, which, unless carefully and conscientiously discharged, invariably results in injury to all concerned.

He must constantly bear in mind that, no matter what the original standard of workmanship may have been, each new piece of work, as it is accepted and paid for, becomes the real standard of that shop. If each is a little further below the original standard than the piece preceding it, one result will be an increased production of pieces and augmented earnings by the workmen. This is apt to be followed by a demand upon the part of the proprietors for a reduction in prices. This reduction being made, it is followed by further deterioration of quality and repeated reductions of prices, until finally a point is reached at which it is utterly impossible for the men to do anything resembling decent work for the prices paid. At the same time the selling prices of the finished articles may have been so much reduced under the pressure of competition with other manufacturers, employing better means to reduce the cost of production, that it is impossible to restore things to a satisfactory basis, and whether the selling prices have declined or not, an increase of piece-work rates is a rare occurrence.

Where things go in this way, the workmen, the foremen, the proprietors and their customers are very apt to become disgusted with piece-work. Yet the trouble is not with the system of piece-work, but is the natural result of the absence of an important and even indispensable part of the system. It should be the duty of the foreman to see to it first that the standard of workmanship is not reduced, but that every piece accepted and paid for is fully up to the mark.

Then, this point being secured, if by the introduction of improved methods, or by more energetic work on the part of the men, there is increased production and earnings, both parties will know just who is entitled to the credit (and recompense) therefor.

So far as we have observed, the system of piece-work, when managed properly, is usually satisfactory to all concerned, though there are of course kinds of machine work to which it is not adapted; and its failure can in almost every instance, we think, be traced to the fact that it had been tried upon work not adapted to it, or by persons not fully comprehending what was required to make it satisfactory.

Cannot Tax Commercial Travelers.

The recent decision by the Supreme Court, declaring unconstitutional a State law imposing a tax upon commercial travelers from other States, will be gladly welcomed by those who believe in unrestricted commercial intercourse between the people of the United States, irrespective of State boundaries. Since it is confessedly largely due to this unrestricted freedom of intercourse that we owe our prosperity as a nation, it seems strange that any State should have desired to impose such a tax, especially since it must inevitably be eventually paid by the consumers of the goods sold, the same as any other element in the cost of their production, transportation and sale. The expenses which are *necessary* in selling machinery, for instance, in the South are just as much a part of the cost of the effective production of that machinery, as is the cost of the machinists' labor employed in constructing it, and will inevitably be considered in fixing the price at which it can be sold. If the customer takes means to increase this element of cost, he simply injures himself, and if the State in which he resides does it for him, the effect is the same.

Lubricating Oils.

It is a mystery that men who are called upon to use lubricating oils—that is, to do the work of using them, and the work resulting from their use—can never understand why, when an oil has been found just right for the purpose for which it is intended, a change is made by those who control the purchasing power. Valuable machinery is often sadly damaged by such changes. The highest priced oil is not always the best, but the best of common oils is generally the cheapest.

When a large quantity of machinery is operated, the quality of the oil used often has an important bearing on the amount of coal burned, and sometimes the rapid destruction of delicate machinery more than overbalances the cost of both coal and oil.

The reason, sometimes, why a change of oil is made when the quality is in every way satisfactory, is that the new "oil man" has an insinuating way with him, that captivates the purchaser, and sometimes, alas! the purchasing agent is captured by other means.

There are reputable dealers in oils, who, a quality having by experiment been found that is best for the purpose, undertake to furnish it of a standard grade as long as desired. Lubricating oils are, at the present day, very commonly a compound of animal and mineral oils, and vary quite widely as compounded for different purposes. Many dealers have been to considerable trouble and expense in getting at the best mixtures, and can frequently give good advice when the purpose for which the oil is to be used is known to them.

The extremely dangerous character of a mixture of molten iron and water was again illustrated in a Pittsburgh iron works recently, where some melted iron became accidentally upset and ran into a puddle of water. An explosion followed, which demolished the furnace and a portion of the mill, scattered the hot iron about upon the men, one of whom was killed, and several others injured. Some idea of the terrific force of the explosion can be gathered from the fact that one of the arms of the man who was killed was blown from his body.

Ordinary prudence would seem to indicate that when melted metal is being handled no water should be about which can possibly come into contact with it. If a ladle of iron is accidentally spilled it will of course almost inevitably do some damage, or injure some one. But the chances for the man getting away from it are fairly good unless water is encountered, when there is immediately such a violent explosion and scattering of hot metal that there is very little chance for the escape of any one without injury. A combination of melted iron and water is as dangerous as gunpowder, and iron workers should always take pains to prevent such a combination being possible.

A great deal of oil is wasted through not employing a suitable filtering device. The needs of high-speed machinery—and higher speeds is always the order of the day—call for the passing of more oil by and over the journals, and while the intention is to make some kind of a second use of this oil where there is any purpose for which it may be used, practically it goes mostly to waste. Oil filters are cheap and simple, and their use ought to be more common. In hundreds of cases their use would effect a very material saving, and frequently they would be the means of bringing about the use of a better quality of oil, which now seems to be too valuable to be wasted.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(500) S. S., New York, will find the spelling "tire" in this country, and "tyre" in England.

(501) A. S., Meadville, Pa., will find information as to the working of injectors in the catalogues of the builders. There is no work published on the subject that gives the desired information.

(502) N. L., Freeport, Ill., asks: What per cent. of the theoretical value of coal is utilized in the best steam power plants? *A.*—We cannot tell the exact figure; possibly as high as 15 per cent. has been reached in exceptional cases.

(503) J. U. S., San Francisco, Cal., asks: Is there any loss in clearance, if compression is carried up to boiler pressure? *A.*—Under ordinary conditions there is loss from clearance. Compression reduces the loss. We must decline to say who builds the best steam engine. There are a good many between which there is little choice.

(504) E. F. B., Buffalo, N. Y., asks: In order to settle a dispute, which is the stronger of the two—a solid shaft, or a hollow one of the same outside diameter? The size of the hole is understood to be about one-third the diameter of the shaft, the shaft to be subjected to torsional, lateral and compressive strains. *A.*—The solid shaft is the strongest in all directions.

(505) F. W. P., ———, Iowa, asks: Please give me the best modern practice in regard to cutting speed in feet per minute of lathes on steel-tired engine wheels. Would you consider 14½ feet per minute a good speed? *A.*—14½ feet per

minute we consider to be good practice; although in some first-class establishments a speed of 16 feet per minute is sometimes adopted.

(506) A. F. M., Newark, N. J., writes: We tin malleable iron; it comes from the bath bright, but after a few days it gets red in spots (copper color) and gradually spreads all over the work, although we keep it covered. Will you kindly tell us the cause or the prevention of it? *A.*—It seems to us that the fault lies in the quality of tin used. Try another and better quality of tin.

(507) E. A. M., Beaver Dam, Wis., asks: Will you please give me a rule for finding the amount of water that will flow through a given size of pipe under different pressures? Where could I find a book or table with such information? *A.*—See answer to Question 281, June 2, 1888. When simply the pressure in pounds per square inch is given the "head" is found by dividing the pressure per square inch at the center of the opening or aperture by .434; the quotient will be the head in feet.

(508) A. A. C., Ayer, Mass., writes: Supposing I have two boilers exactly alike in every particular excepting the heating surface of the tubes. One has plain tubes, giving 10 square feet of heating surface per square foot of grate surface. The other boiler has corrugated tubes giving 20 square feet of heating surface per square foot of grate surface. What I wish to know is what difference in amount of fuel will be required to keep the same volume of steam? *A.*—We do not know of any data upon which to base a calculation. We believe the only way to determine the difference between the amount of fuel used in these boilers is by actual tests.

(509) W. R. A., Salem, N. J., writes: I am working in a small jobbing shop which employs about seven men. Having learned, so to speak, my trade in this shop, I would ask you to tell me where and how I could learn the most. We only have a few tools, and by staying in this shop I can only learn how to use these few. If I could obtain work in a large shop, would I not learn more? I have been working on dies a good part of the time. I find that in talking with advanced mechanics that I only know how the work is done by us, and that our way, a good many times, is not always the best. *A.*—Many of our best mechanics have learned their trade in small jobbing shops, and we believe that these shops are good places to learn a trade. Mechanics accustomed to work in small jobbing shops can get along better in large shops, should they choose to work in such, than men accustomed to work in large shops can get along in smaller places, should circumstances compel them to do so. In large shops men are liable to become specialists rather than mechanics; neither will they learn to do work in any other way than such as has been established there. We do not know the work you have to do in your present position, neither do we know the kind of tools to which you have been accustomed, but on general principles we should advise you to stay where you are until you see an opening for an advanced position. In the meantime pursue the course which you have been pursuing, that is, talk with good mechanics, compare their way of doing work with your way; read good technical papers, and devote your leisure hours to study, be observant, visit larger works whenever you have a chance, do your work faithfully and cheerfully, and we believe you will not regret the time you have spent in the small jobbing shop.

(510) G. B. G., Boston, Mass., asks: Can you tell me the approximate consumption of coal per horse-power per year for small engines with variable cut-off of six to ten horse-power? *A.*—Small engines of the class you mention will require from 4 to 5 pounds of coal per horse-power per hour. At 4 pounds of coal per horse-power per hour, a six horse-power engine will require $6 \times 4 = 24$ pounds of coal per hour; or $24 \times 10 = 240$ pounds of coal per day of 10 hours. Allowing 300 days of 10 hours per year, the consumption of coal for a six horse-power engine will be $240 \times 300 = 72{,}000$ pounds or 36 tons (2,000 pounds per ton) per year. 2. State the approximate power required to run six milling machines and six sixteen-inch lathes. *A.*—You do not state the size of the milling machines. With the aid of the following table you may generally obtain a close approximation of the power required to run any machine.

Driving power of oak tanned leather belts:

Width of belts traveling 750 feet per minute	Horse-Power.
1 inch	1. horse-power.
2 "	2.142 "
3 "	3.480 "
4 "	5.028 "
5 "	6.788 "
6 "	8.726 "
7 "	10.953 "
8 "	13.360 "
9 "	15.982 "
10 "	18.825 "
11 "	21.882 "
12 "	25.158 "

Example: How many horse-power will a 3-inch belt furnish, traveling over a 12-inch pulley, the shaft making 150 revolutions per minute? The circumference in feet of a 12-inch pulley is equal to 3.1416 feet. Hence the speed of belt is equal to $3.1416 \times 150 = 471.24$ feet per minute. According to the table a 3-inch belt running at 750 feet per minute gives us 3.480 horse-power, therefore at 471.24 feet per minute we have

$$\frac{471.24}{750} \times 3.480 = 2.18 +$$

horse-power, which the belt at the given speed will furnish.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Fuel oil burners. A. E. Jenkins, Scranton, Pa.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb-Knitting Machine Co., Chicopee Falls, Mass.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co.; Bellefonte, Pa.

Drop presses, punches and shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Castings for small and medium sized vertical engines. Humphrey's Foundry, Bellefontaine, O.

Pattern letters and figures to place on patterns for castings. H. W. Knight & Son, Seneca Falls, N. Y.

"How to Keep Boilers Clean." A book mailed free by James E. Hotchkiss, 120 Liberty st., N. Y.

Davis Key-Seating Machines, kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N. W. Washington, D.C. Send for pamphlet and references

Ice and Refrigerating Machines, 13½ sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity. Currier & Snyder, Worcester, Mass.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y City.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Nov. 17, p 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

See illustration of improvements in Hooks for Steam Engines on page 5. For further particulars address T. C. Dill Machine Co., 726 Girard av., Philadelphia, Pa.

Patents—Gov't and atty's fees refunded upon failure to obtain patent after favorable report by me. R. G. DuBois, expert in patents, 928 F street, Washington, D. C.

A gold medal and two silver medals were awarded The Waterhouse arc system at the Centennial Exposition, Cincinnati. Address The Waterhouse Electric and Mfg. Co., Hartford, Ct.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N.Y.

A system of easy lettering by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N.Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

"Practical Drawing." By J. G. A. Meyer. The above series of articles now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Nov. 3, 1888 issue, 62 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 76 articles have thus far appeared up to and including the Oct. 27, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York

MANUFACTURES

J. Lang will build malleable iron works at Emerson, Ga.

Grier Brothers, Milford, Del., will build an iron and brass foundry.

Burly & Usher contemplate building a shoe factory at Springvale, Maine.

A bobbin factory is being built at Sugar Hill, N. H., by Minot Edmunds.

The Fort Wayne (Ind.) Water Power Company has been incorporated.

The building of boilers is to be started by the Athens (Ga.) Foundry and Machine Works.

The machine shop of Hughes & Horton, Lowville, N. Y., is being enlarged by an addition 30 x 40 feet.

Daniel Kelley is building a machine shop at Back Bay, Portland. He builds agricultural implements.

The McCloud & Sparks Furniture Company, with a capital of $30,000 has been chartered at Fort Smith, Ark.

The G. A. Gray Co., Cincinnati, Ohio, received first premium on lathes and planers at the Centennial Exposition.

The Laidlaw & Dunn Co., of Cincinnati, Ohio, received a medal for their duplex steam pump at the Cincinnati Exposition.

George E. Knowles, of Trenton, N. J., will build a knitting factory at Sheffield, Ala. The main building will be two stories, 50 x 200 feet.

A Mr. Kingsland, of Pittsburgh, Pa., claims to have invented a process for making steel equal to Mushet steel at only a fraction of the cost.

Perkins & Co., Grand Rapids, Mich., have brought out a new shingle machine that appears to possess a good deal of merit for doing good, rapid work.

The Union Malleable Iron Company, Moline, Ill., have started their shops again after a year's inactivity. They report the outlook as very encouraging.

The Mason Regulator Co., Boston, Mass., has been obliged to run night and day, to fill orders for their reducing valves, which are used by several car heating companies.

R. Muir & Co., of Winnipeg, will build a flour mill at Treherne, Man., having accepted the offer of the citizens to give a $6,000 bonus and exemption from taxation for 20 years.

A company is prospecting for natural gas at Denison, Tex. A well 500 feet has already been dug, and work will be continued until it is definitely ascertained whether that town lies in the great gas region or not.

The National Rolling Mill, McKeesport, Pa., are constructing a plate mill department for rolling plates large enough for 24-inch pipe. It is expected this department will be put in operation about the first of January.

The Dallas (Texas) Cotton Mill was recently started. The machinery, which is driven by a 375 horse-power engine, includes 11,000 spindles, 200 looms, 90 carders, 400 speeders, three breakers and four finishers and two sets of drawing frames.

The Briggs Iron and Tool Company, at Findlay, Ohio, will erect a forge building, 160 x 40, on their premises. The new building will contain a guide mill. The building to be occupied and used in the manufacture of chain is rapidly approaching completion.

The Kellogg Mining and Milling Company, capital stock $100,000, has been organized, to develop mines and do a milling business near Little Rock. J. G. Sandidge is president; G. F. Martin, vice-president; Anthony Koenen, secretary, and C. T. Walker, treasurer.

The Link Belt Machinery Company, of Chicago, have begun the erection of their new foundry, to be located on their 5½-acre tract at 39th street and Stewart avenue, Chicago. The structure will be 286 feet long by 87 feet wide, and will probably be completed before spring.

The Chicago, Burlington & Quincy people have notified the Indianapolis Car Works that they have been awarded the contract to build 1,000 box cars for that company, to be delivered as fast as practicable. This contract, with those recently taken, will keep the works busy until spring.

Lodge, Davis & Co., Cincinnati, Ohio, write us that they have recently received heavy orders for machine tools. They also write that they sold as many as 35 and 40 duplicates of tools on exhibition at the Cincinnati Exposition. They have lately shipped two car loads of tools to San Francisco.

The increase in the Niles Tool Works, Hamilton, Ohio, gives them a working space of 116 x 400 feet, divided into three sections. Two twenty-ton traveling cranes command the entire middle sections, and stationary cranes cover the side sections. The company has just completed a new blacksmith shop 55 x 120 feet.

The Lincoln Iron Works, Rutland, Vt., have issued a very complete catalogue, fully illustrated, of machinery for handling and working marble and stone. They manufacture a very complete set of machinery for the purposes named. The catalogue also contains tables of weights of iron, areas of circles, standard hoisting ropes, decimal equivalents, etc.

The Waterhouse Electric & M'f'g Co., of Hartford, Conn., were awarded a gold medal at the Cincinnati Centennial Exposition, and two silver medals, the same covering the arc light plant at the Exposition. This is the second gold medal awarded to the Waterhouse Company, the first being received from the Mechanics' Fair, Boston, in December last.

We were recently shown a specimen of Tobin bronze, made by the Ansonia (Conn.) Brass and Copper Company, which is tied into a knot, apparently about as well as could be done with a string of the same diameter. Tests by Prof. Thurston showed this metal to have a tensile strength of 67,000 and upwards. The New York offices of this company are 19 and 21 Cliff street.

Jones & Rogers, No. 5 West Fourth street, Cincinnati, O., are designers of special machinery for metal or wood working; also factory plans, etc., for anyone requiring such service. They are also builders of gearing, friction pulleys and couplings, shafting vises and power-measuring machines, automatic brakes for electric railway trucks, etc. They issue a large card describing what they do.

A co-operative cotton mill is proposed at Camden, S. C. The capital is to be raised by weekly assessments of 50c. per share. Subscribers who pay in advance will be given three notes of the company, payable in 66, 134 and 200 weeks respectively, and bearing 7 per cent. interest from date. Each note at its maturity will be taken up by the company, and a certificate of stock for principal and interest given.

Miller, Metcalf & Parkin, steel makers, of Pittsburgh, Pa., and 480 Pearl street, New York, have issued a little book, handy for the pocket, which contains the most complete tables of the weight of sheet and plate steel of any we remember to have seen, also tables of the weight of drill rod wire, polished compressed drill rods, areas of circles, decimal equivalents, gauge measurements in thousandths of an inch, and rules for finding the areas of various forms. It is a book that every mechanic will find useful, and is sent free on application. They also send free a valuable book on the working of steel.

The Beckett Foundry and Machine Company, Arlington, N. J., have lately shipped one of our steam hoists to the estate of J. Couper Lord, for one of their iron mines at Port Oram, N. J. This hoist has two steam cylinders, 15 inches diameter x 24 inch stroke of piston, and two drums, 6 feet diameter x 4 feet long, each fitted with powerful jaw brakes and steel band friction driving arrangement. The drum shaft is 8 to 9 inches diameter x 24 feet long, supported by four heavy bearings. The main driving spur wheel is 12 feet diameter x 10 inch face and 3 inch pitch. The total weight of this machine is about 26 tons.

The Hussey Re-Heater and Steam Plant Improvement Company, 15 Cortlandt street, New York, send us a long list of prominent manufacturers that have adopted their re-heaters. One of their recent orders is from the Sewall & Day Cordage Co., of Boston, Mass., for both a Hussey re-heater and a compound automatic low pressure feed-water heater, for use in their new factory at Brighton, Mass. Both apparatus are to be placed in the main flue between the boilers (aggregating about 1,000 horse-power) and the chimney, which is about 175 feet high. The waste gases of combustion from the boilers will first pass the Hussey re heater, to re-heat the exhaust steam; and the water heater will then utilize the remaining heat in the gases for heating the feed-water to 212 degrees Fahr. These heaters for Sewall & Day taken together weigh about 24,000 pounds.

The Southern Furniture Manufacturing Company have bought from the Purslow estate the property bounded by Tchoupitoulas, the river and Napoleon avenue and Berlin street, consisting in all of about three large squares, with batture privilege, for $20,000. They intend to commence to build as soon as possible. The buildings will consist of one four-story brick building, 100 feet wide by 300 feet long, which will be the main factory. Another four story brick building, 80 feet wide by 300 feet long, will be the storeroom and finishing department. The finishing room will be 80 feet square, and will be fire-proof. It is intended to put nothing but the best and latest improved machinery in all of the different departments, as it is a well-known fact that furniture can be manufactured here as cheap, if not cheaper, than anywhere in the United States if the proper machinery is employed. There is enough stock already taken to complete the factory. The company have already engaged a superintendent and foremen for the different departments from the West.—New Orleans *Times-Democrat*.

The Bridgeport Boiler Works, Bridgeport, Conn., Wm. Lowe, proprietor, have met with their usual good fortune in orders for fall and winter work for their specialties—the Lowe boiler and the Lowe feed-water heater, and other kinds of boilers, and a variety of other work which keeps their facilities fully employed. Amongst the orders for the Lowe boilers is one for a 100 horse-power, with all improvements, for the Joseph Dixon Crucible Co., Jersey City, N. J., a duplicate of one furnished them two years ago; an order for 600 horse-power of Lowe boilers for the new works of the Aluminum Brass and Bronze Co., of Bridgeport, Conn., and others of from 50 to 75 horse-power. Amongst the orders for Feed-Water Heaters is one of 600 horse-power for the Edison Electric Light Co., Kansas City, Mo. This makes the third one of this size sent to Kansas City in a short time. The Pratt & Whitney Co., of Hartford, have adopted the Lowe system of traveling transfer cranes for their new works and warehouse at their works at Hartford, Conn., and find it so capable and convenient that they will advocate, sell, and make for others.

Machinists' Supplies and Iron.

NEW YORK, Nov. 10, 1888.

Iron—American Pig—The general features of the market remain the same as at our last report. Finished iron is in good demand, a fact which tends to impart a feeling of confidence in the future. We quote Standard Lehigh and North River brands $18.50 to $19 for No. 1 X Foundry; No. 2 Foundry, $17 to $17.50, and Grey Forge, $15.50 to $16.25.

Scotch Pig—We quote Coltness, $21.50; Gartsherrie, $21; Summerlee, $21.75; Eglinton, $19.25 to $19.50; Dalmellington, $20.25; Clyde, $20.50, and Langloan, $20.50.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—See bottom of third column, page 11.

A draftsman with experience wants a position. Address P. Q., AMERICAN MACHINIST.

Good mechanical draftsman wants position in boiler and engine work. Box 44, AM. MACHINIST.

Draftsman—A competent man wants situation as assistant draftsman. Age, 30. Box 37, AM. MACH.

Young man, age 23, good exp. in shops and drafting room, wants employment. Box 42, AM. MACH.

A first-class pattern maker, English, wants a position as foreman; good draftsman; age 33. Box 35, AMERICAN MACHINIST.

Wanted—By practical patternmaker and draftsman, position as foreman pattern maker. S. K. AMERICAN MACHINIST.

Wanted—A young man in drawing office, with fair knowledge of drafting and some experience. The D. A. Tompkins Co., Charlotte, N. C.

Position wanted by young man as draftsman or foreman in machine shop; good experience; used to handle men. Address S. N., AM. MACHINIST.

Wanted—After Jan. 1, 1889, position as machine shop foreman, accustomed to saw-mill and engine work; best ref. Address A. H., AM. MACHINIST.

Mechanical draftsman, competent designer, able to estimate work and handle men, is open for engagement; first-class references given. Address Draftsman, AMERICAN MACHINIST.

Draftsman—Employment wanted by competent mech. engineer; English trained; thoroughly practical; British Board of Trade, 1st class; references American and Foreign. Ability, AM. MACHINIST.

Wanted—Position as mechanical draftsman, by young man; has had 6 years' practical experience amongst marine and general work in England; also good theoretical training. Box 41, AM. MACHINIST.

Wanted—Honest, capable man to take charge of small machine shop in Boston, that turns out a variety of work; must be capable, systematic, and in every way reliable; state experience, last position, and wages expected. Box 43, AM. MACHINIST.

Wanted—English fitters or turners returning home, who have worked in first-class shops in New England, manufacturing highly finished work, to please apply, either by letter or personally, to George Richards & Co., Limited, Broadheath, near Manchester, England.

1889—Two mechanical engineers, having large experience in machinery and tools, commanding the English, French, German, Italian and Scandinavian languages, desire to represent an American firm at the Paris Exhibition in '89; correspondence solicited. Address E. F. G., AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent steel tube scrapers are unquestionably the best. Crescent Mfg. Co., Cleveland, Ohio.

Crescent boiler tube cutter, for setting new and removing old tubes. Crescent Mfg. Co., Cleveland, O.

August C. Christensen, 24 State st., N. Y., consulting engineer for hydr. and pumping machinery, etc.

For Sale—Cheap, a set of small steam engine patterns. Address A. G. Hubbard, Sterling, Ills.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

For Sale—One Daniels Planer, made by H. A. Richardson, Worcester, Mass., Table 18x3½ ft. Bed 36 feet. E. C. Stearns & Co., Syracuse, N. Y.

Wanted—Partner with $1,000 or $2,000; manufacturing machinists' small tools; good machinist preferred. Address BOX 40, AMERICAN MACHINIST.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati O.

Wanted—Partner to take interest in a machine shop in the West, with good paying buiness; a man wanted who can invest $4,000 or $5,000 cash. K. K., care AMERICAN MACHINIST.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale—Machine Shop and Foundry, at a bargain, in Western Ohio; business profitable; can give satisfactory reasons for selling. Address M., care AMERICAN MACHINIST.

FOR SALE. CORLISS ENGINES.

The Fishkill Landing Machine Co., located at **Fishkill, on the Hudson, N. Y.,** offer to manufacturers and others desiring a well-built, economical and durable engine, their improved **CORLISS ENGINES.** They are endorsed by many reputable engineers and persons using them. Address as above.

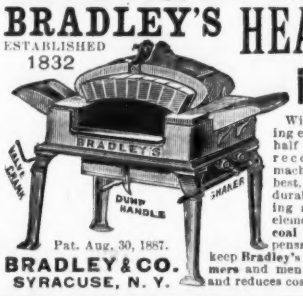
BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER

ESTABLISHED 1832

Combines the best elements essential in a first-class **Hammer.** Has more good points, does more and better work and costs less for repairs than any other **Hammer** in the world.

BRADLEY'S HEATING FORGES.

ESTABLISHED 1832



Pat. Aug. 30, 1887.

With a manufacturing experience of over half a century, we recommend these machines to be the best, simplest, most durable and combining all the essential elements. **For hard coal or coke.** Indispensable in all shops, keep **Bradley's Cushioned Hammers** and men fully employed and reduces cost of production.

BRADLEY & CO.
SYRACUSE, N. Y.

—COMPOUND—
Automatic Water Heater,

Heats water to 212°, without pressure. With pressure will heat water to 320°.

NO COST FOR FUEL. UTILIZES WASTE HEAT. NO SWEATING. NO CORROSION. SAVES FROM 15 TO 25 PER CT. OF FUEL.

The most perfect and effective Feed Water Heater ever devised.

SEND FOR CIRCULAR.

THE HUSSEY RE-HEATER
—AND—
STEAM PLANT IMPROVEMENT CO.
15 Cortlandt Street, New York.
A. S. HATCH, Pres. S. D. BREWER, Gen. Man.

"Star" Foot Lathe Swings 9x25 in.

LATHE

Screw Cutting Automatic Cross Feed, etc.

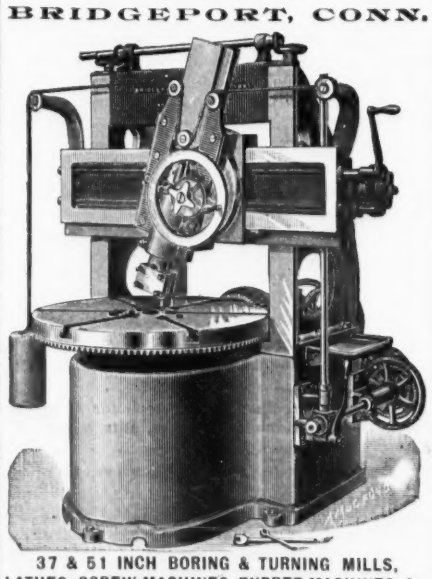
Scroll Saws, Circular Saws, Lathes Mortisers.

Catalogue Free of all our Machinery.

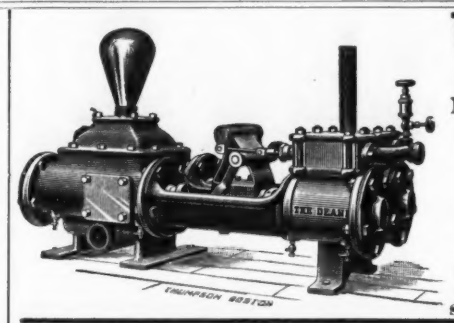
Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y

PATENTS THOMAS P. SIMPSON, Washington, D. C. No atty's fee until Patent obtained. Write for Inventor's Guide.

Bridgeport Machine Tool Works,
E. P. BULLARD, PROP.
BRIDGEPORT, CONN.



37 & 51 INCH BORING & TURNING MILLS, LATHES, SCREW MACHINES, TURRET MACHINES, &c.



THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.,
New York, Boston, Chicago, Philadelphia St. Louis,
Manufacturers of
STEAM and POWER
PUMPS
FOR ALL PURPOSES.
SEND FOR CATALOGUE.

The Hendey Geared Friction Planer,
16 inch x 16 inch x 4 feet.

For Die Work and use in Tool Rooms this planer is particularly adapted. It will plane accurately to a line, and stroke can be quickly changed from one inch to full capacity of table (4 feet), maintaining at the same time a uniform cutting speed. It has a cone pulley for change of speed, and automatic horizontal, vertical and angular feed. For above work it has proved a superior tool.

For Planers, Shapers or Engine Lathes, address
THE HENDEY MACHINE CO., TORRINGTON, CONN.

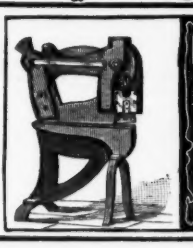
MACHINERY STEEL CRUCIBLE or BESSEMER. HARD OR SOFT. Strong. Sound. Uniform.
MILLER, METCALF & PARKIN,
64 & 66 SO. CLINTON STREET, CHICAGO, ILLS. CRESCENT STEEL WORKS, PITTSBURGH, PA. 480 PEARL STREET NEW YORK, N. Y.

Sebastian, May & Co.'s Improved Screw Cutting
FOOT AND POWER **LATHES**

Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
167 West Second Street, CINCINNATI, O.
OUR SPECIALTIES, 8, 12, 14 and 18 inch Lathes.

STEPHENS' PATENT VISES.

QUICK-ADJUSTING CAM AND TOGGLE JOINT.
Stationary or Patent Swivel Bases.
INCOMPARABLE FOR STRENGTH, DURABILITY FIRM HOLD AND QUICK WORK.
Has improved Taper, Pipe and other attachments. Made in 2, 2¾, 3½, 4½, 5½, and 6½ inch width of jaw.
Sold by the Trade. Send for Circular.
TOWER & LYON, MFR'S,
95 CHAMBERS ST., NEW YORK.



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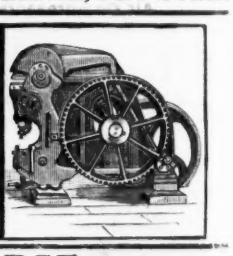

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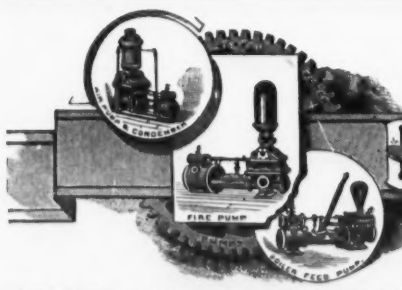

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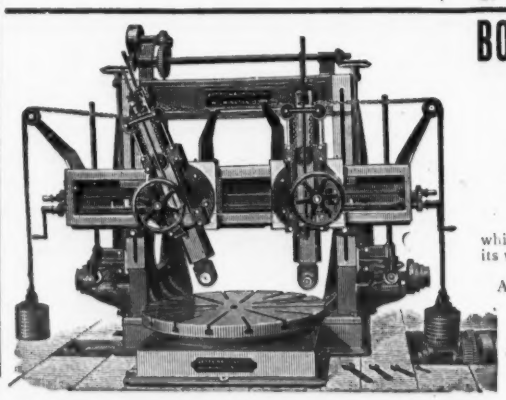

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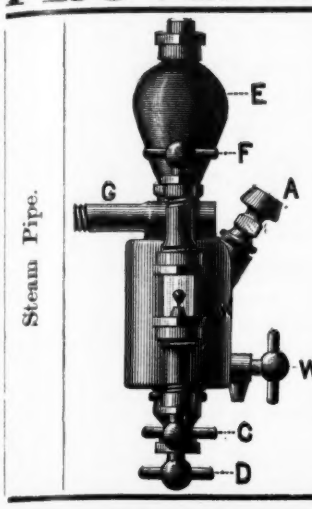

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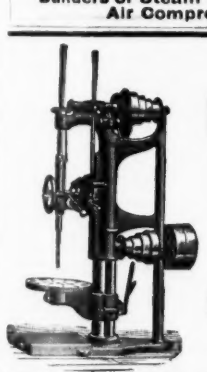

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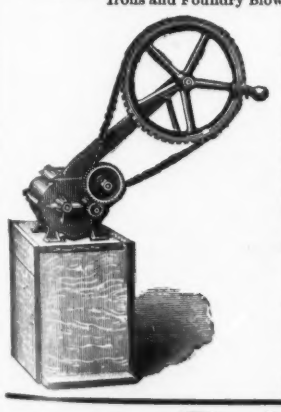

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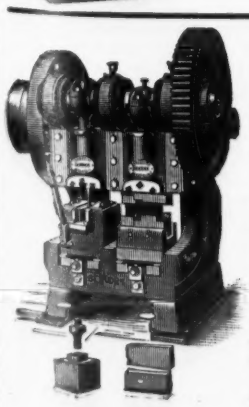

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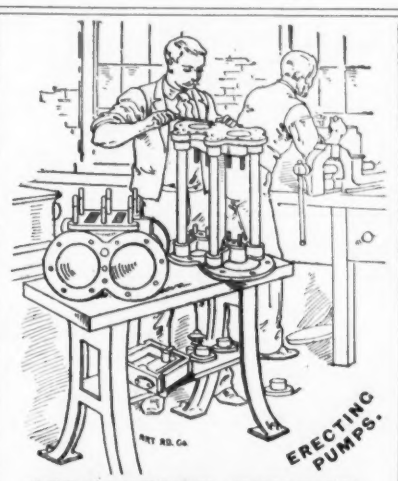

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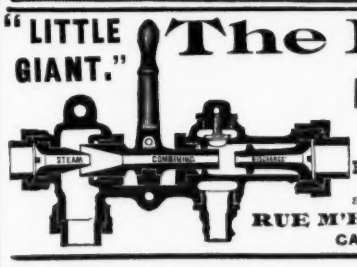

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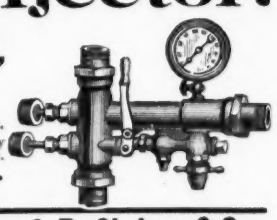

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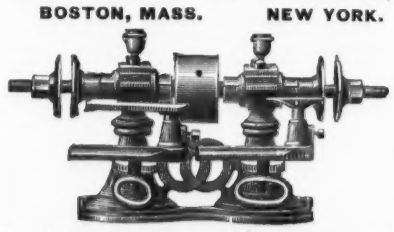

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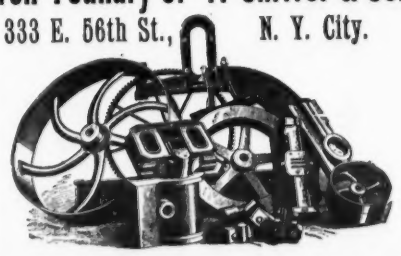

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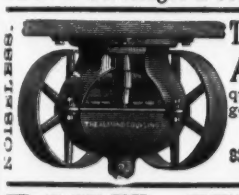

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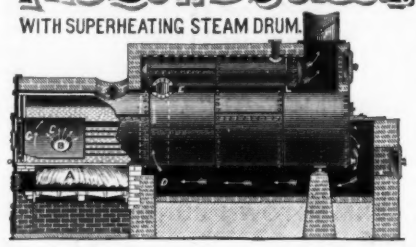

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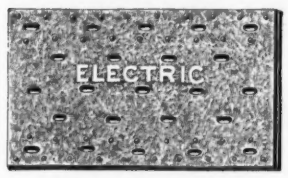

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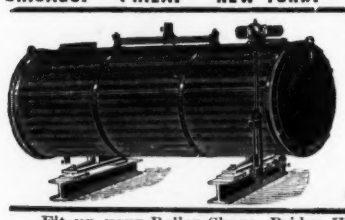

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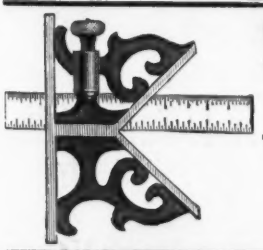

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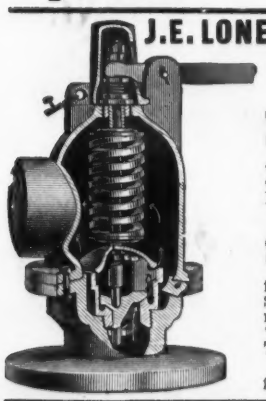

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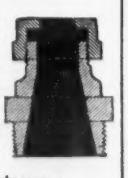

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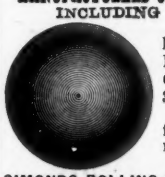

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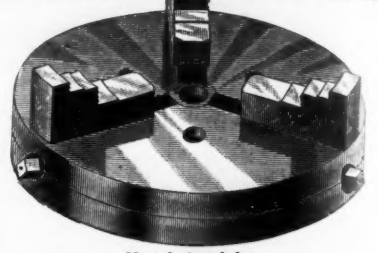

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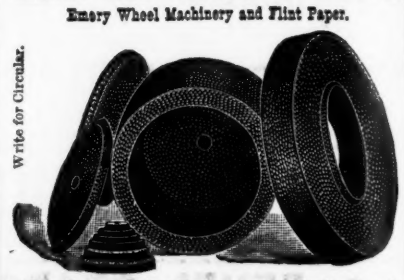

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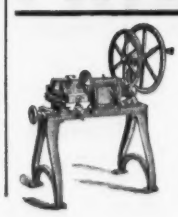

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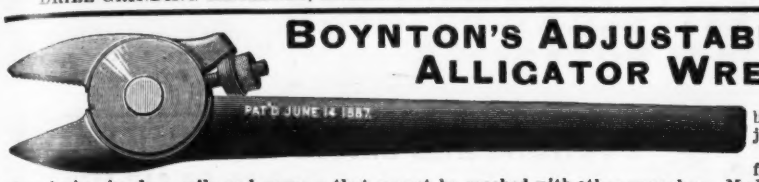

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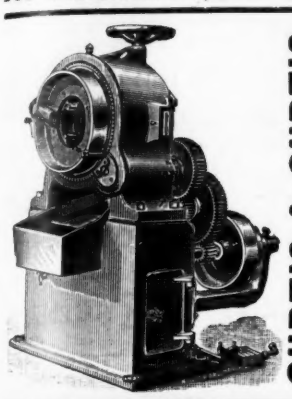

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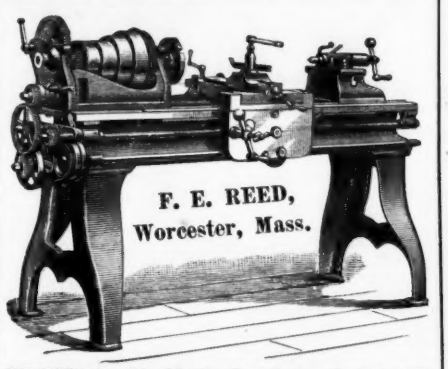

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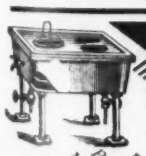

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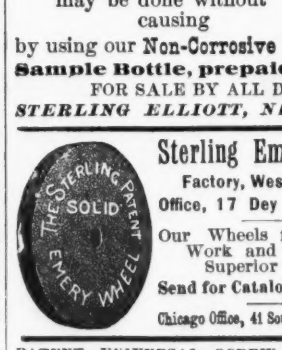

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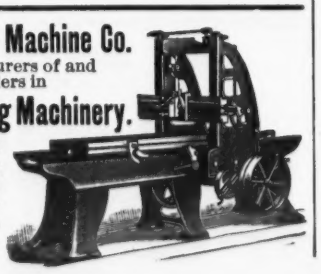

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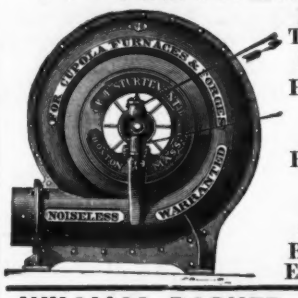

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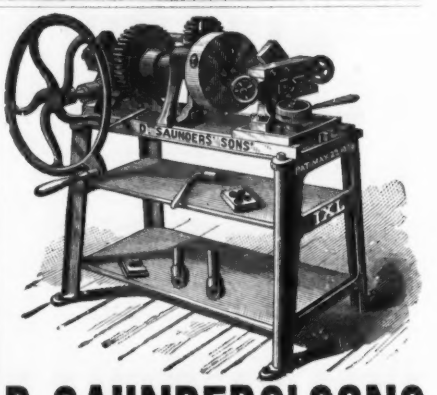

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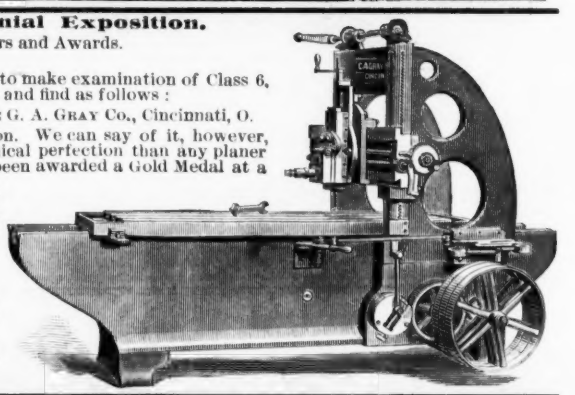
D. D. MARTIN, WM. CORRY, M. L. ANDREW. } *Jurors.*

The Board of Commissioners have awarded a Silver Medal.



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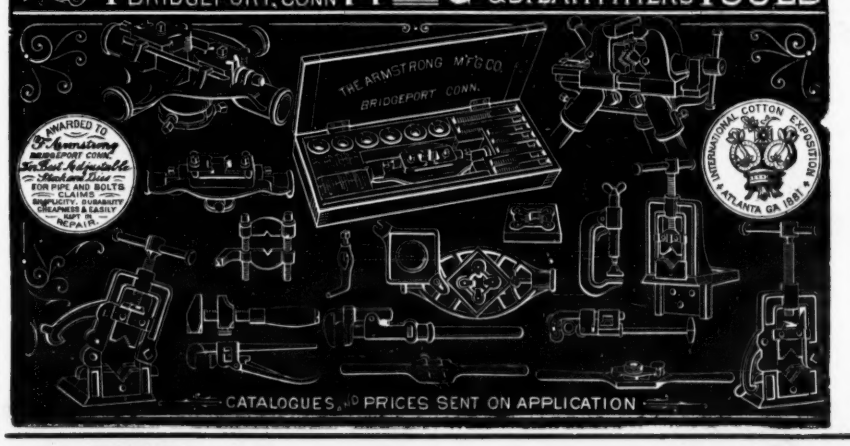

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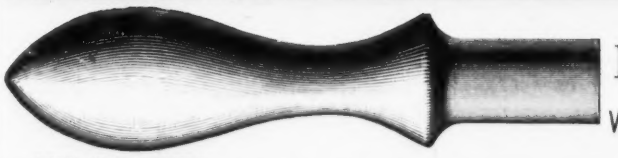

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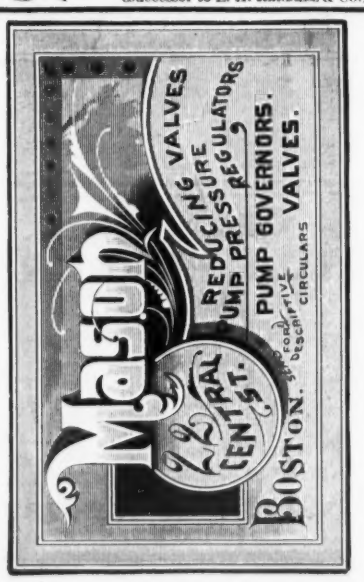

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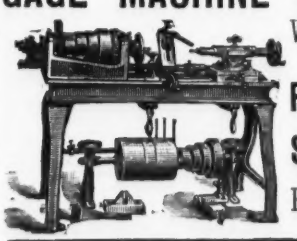

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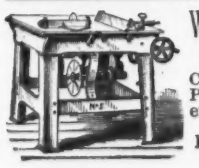

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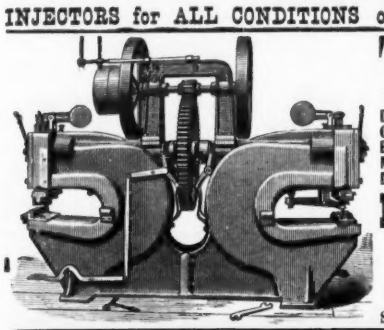

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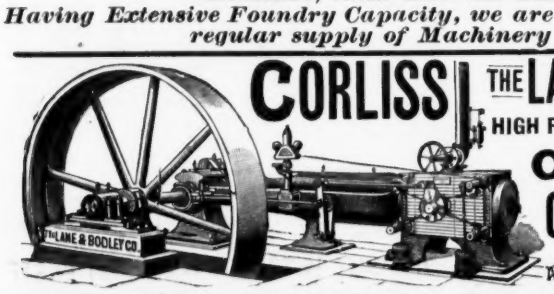

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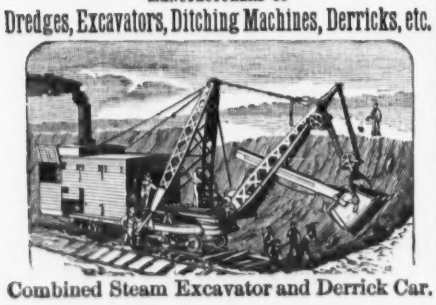

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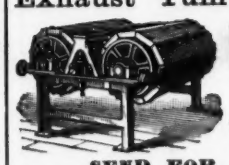

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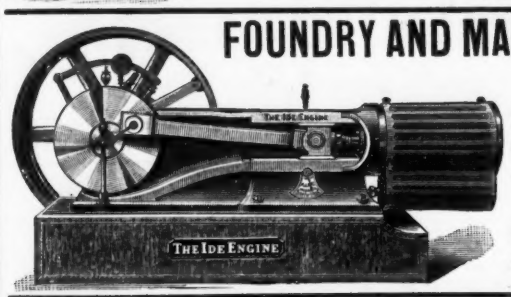

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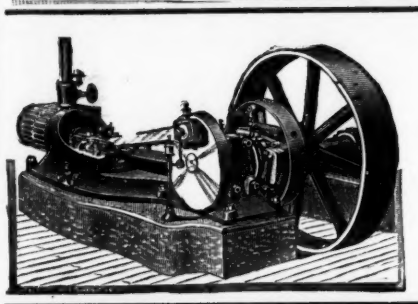

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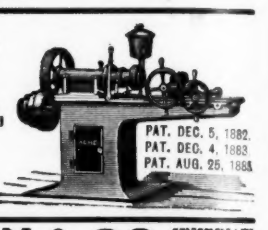

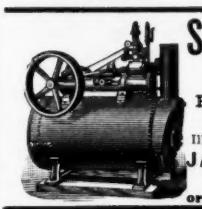

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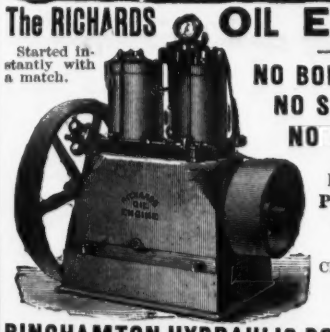

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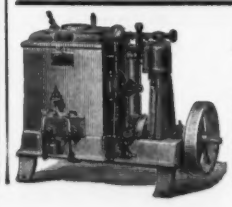

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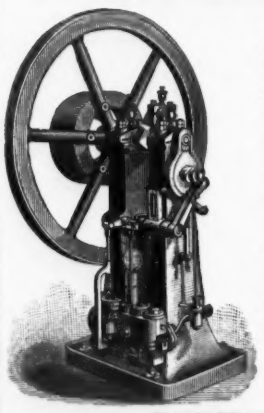

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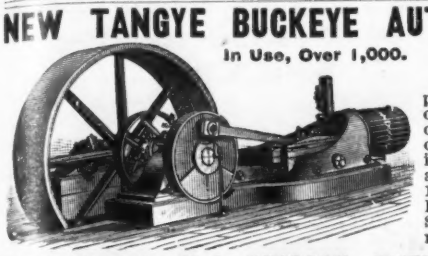

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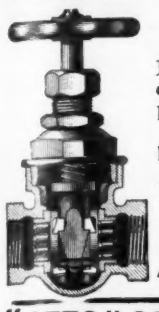

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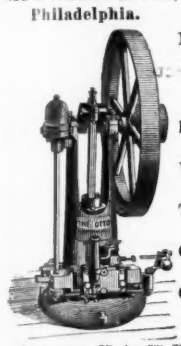

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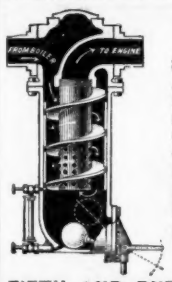

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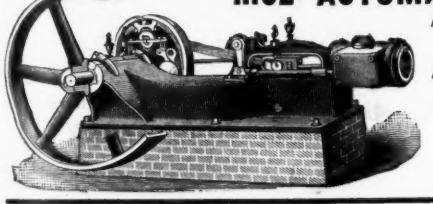

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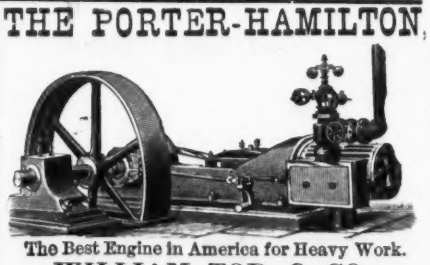

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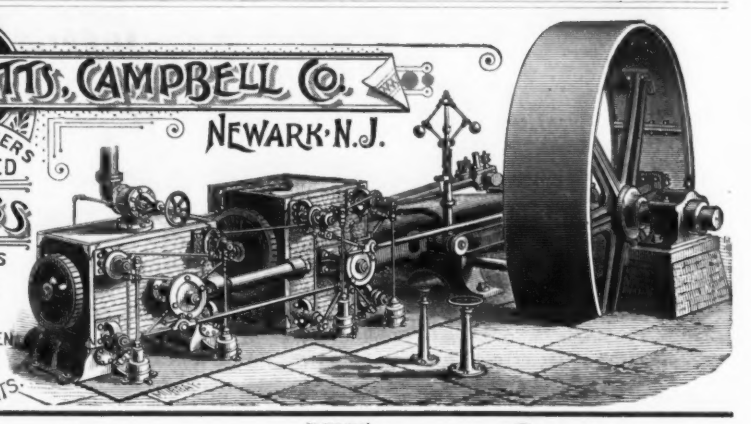

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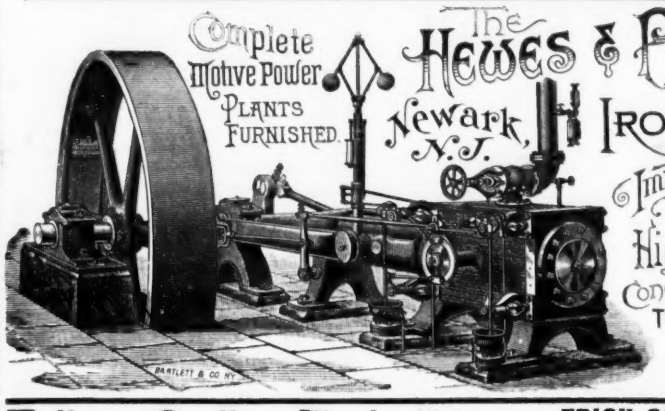

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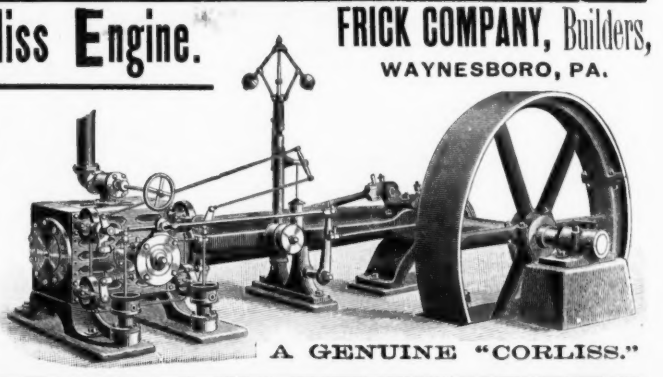

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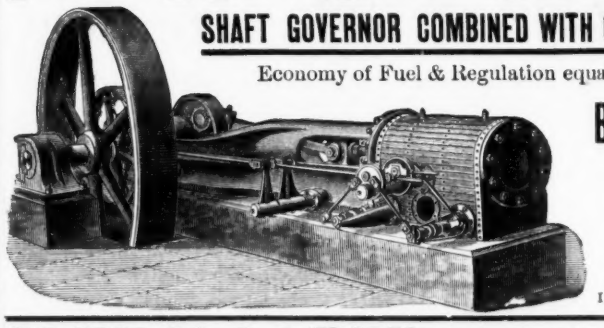

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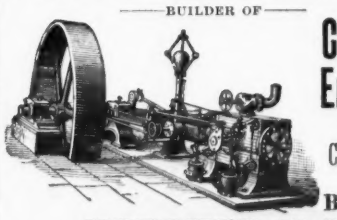

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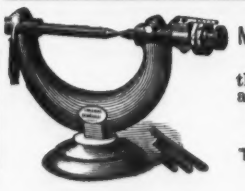

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Yours truly, JOHN S. COOKE, *President.*

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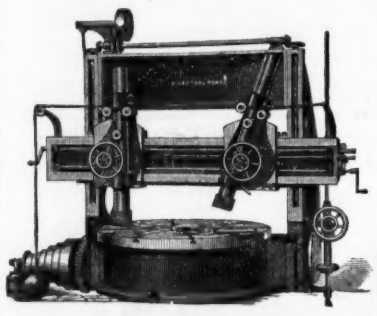

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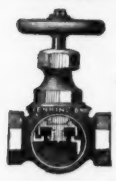

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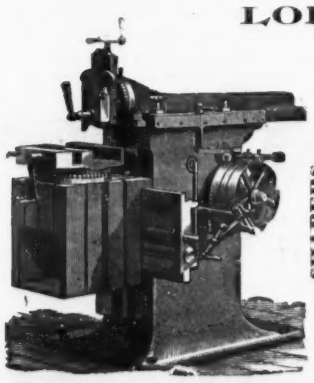

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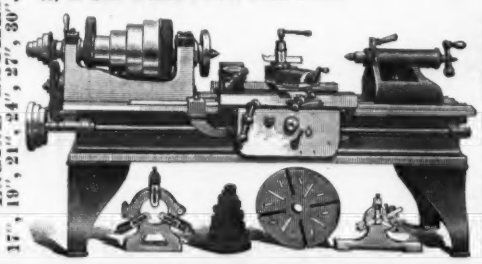

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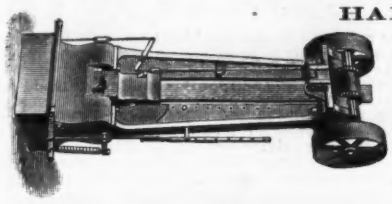

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